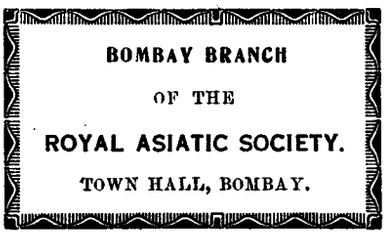
Annual Report of the
Imperial Bacteriologist
1895-96, 1896-97, 1898-99, 1901-02
1902-03, 1905-06 and 1906-07

00134324



Digitized with financial assistance from

Government of Maharashtra

on 01 February, 2020

ANNUAL REPORT

OF THE

134324

IMPERIAL BACTERIOLOGIST

FOR THE OFFICIAL YEAR

1895-96., 1896-97, 1898-99
1901-02, 1902-03, 1905-06, 1906-07

No. 74 of 1896.

Office of the Imperial Bacteriologist,
dated the 26th May 1896.

To

THE INSPECTOR GENERAL,
CIVIL VETERINARY DEPARTMENT,
SIMLA.

SIR,

I have the honour to forward my Annual Report for the year 1895-96, in accordance with the instructions from the Government of India, Revenue and Agriculture, conveyed in their letter No. 3151-36, dated 6th November 1893, communicated under your office letter No. 2090 M, of the 14th idem.

I have the honour to be,
Sir,
Your most obedient Servant,
ALFRED LINGARD, M.B.,
Professor of Comparative Pathology,
and Bacteriology, C. V. D., India.

CONTENTS.

PAGE.

REPORT 7

APPENDIX I—

Journal for 1895-96 11

APPENDIX II—

Outbreaks of Surra during recent years—

(*a*) In districts of the Punjab 11

(*b*) Do. do. North-West Provinces 13

(*c*) Do. do. the Bombay Presidency 14

(*d*) Do. do. Burmah 14

Map showing the districts where Surra outbreaks have been prevalent during the years 1893—1896.

Remarks 15

APPENDIX III—

Physiological and pathological problems *re* equines, during health and the phases of Surra 16

A.—*Untreated cases of Surra.*

Horse No. XCII. Summary and Table of Results 16

„ „ XCIII. Ditto ditto 17

B.—*Treated cases of Surra.*

(*a*) Arsenic, and later, double Iodides of Arsenic and Mercury ... 18

Horse No. LXXXIX (Cured)... 18

(i) Summary and Table of Results 18

(ii) Table of Nitrogen ingested and egested during 26 weeks subsequent to treatment 19

(iii) Total gain by Nitrogen—Fat, moisture, &c. 19

(iv) Total dry matter digested during whole period ... 19

(v) Table showing per cent. of dry matter digested during 26 weeks convalescence from Surra 20

(vi) Water excreted 20

Horse No. XCI. Summary and Table 21

(*b*) Arsenic 21

Horse No. XCVI. Summary and Table 22

C.—*Preliminary Treatment*—

(*a*) Arsenic (54 days) 22

Horse No. XCVIII. Summary and Table 22

(*b*) Tri-iodide of Arsenic and Biniodide of Mercury (46 days) ... 22

Horse No. XCIX. Summary and Table 24

Table showing the chief facts connected with the above-mentioned animals, during the different periods of health and disease (Surra) massed together 26

Summary of results obtained from investigations with the ingesta and egesta, during a period of observation before and succeeding inoculation with Surra. Animals untreated—

Horse No. LXXXIX 27

(i) Summary and Tabular Statement 28

(ii) Nitrogen ingested and egested. Table 29

(iii) Water excreted. Table 29

(iv) Quantity of dry food digested during paroxysms and intermissions 30

(v) Quantity of dry food digested during whole period ... 30

PAGE.

(vi) Blood 30

(α) Number and ratios of corpuscular constituents in health and disease, together with the number of hæmatozoa present in the paroxysms 30

(β) Hæmoglobin per cent. in health and disease ... 31

(γ) Percentage of corpuscles in massed periods ... 31

Mule I.—

(i) Summary and Tabular Statement 31

(ii) Nitrogen ingested and egested, showing total loss. Table ... 34

(iii) Percentages of water excreted as urine, dung, and by lungs and skin 34

(iv) Percentage of dry matter digested during the whole period ... 35

(v) Percentages of dry matter digested during health and phases of Surra 35

(vi) Blood 36

(a) Number and ratios of corpuscular constituents in health and disease, together with the number of hæmatozoa present in the paroxysms 36

(b) Percentage of corpuscles in each period as compared with health 36

Mule II.—

(i) Summary and Table 36

(ii) Nitrogen ingested and egested, showing total loss. Table ... 39

(iii) Percentages of water excreted as urine, dung, and by lungs and skin 39

(iv) Percentages of dry matter digested during health and phases of Surra 40

(v) Percentage of dry matter digested during the whole period ... 40

(vi) Blood 40

(a) Number and ratios of corpuscular constituents in health and disease, together with the number of hæmatozoa present in the paroxysms 40

(β) Hæmoglobin percentages in health and disease 40

(γ) Percentage of corpuscles in each period as compared with health 41

Remarks comparing the results obtained in the cases of Mule I and Mule II 41

Table showing the chief facts connected with the above-mentioned animals (Horse No. LXXXIX (2nd Series), Mule I and Mule II) during different periods of health and disease, (Surra) when the various paroxysms and intermissions are respectively massed together 43

Summary of observations made with regard to the changes occurring in the constituents of the urine, and the ingesta and egesta, before and after several inoculations with the hæmatozoon of the Bandicoot, and before and after the administration of the double Iodides of Arsenic and Mercury—

Donkey—(i) Summary and Tabular Statement 44

(ii) Nitrogen ingested and egested, showing total loss. Table... 46

(iii) Water excreted 46

(iv) Percentage of dry matter digested during periods of observation after unsuccessful inoculation with the hæmatozoon of the Bandicoot, and during and after the administration of the double Iodides of Arsenic and Mercury 47

(v) Percentage of dry matter digested during the whole period. 47

(vi) Blood 47

Number and ratio of the different corpuscular constituents in health, and after inoculation 48

PAGE.

Summary showing the number and ratios of the corpuscular constituents of the blood of Surra Horses subjected to treatment with Arsenic and Iron; together with the days of disease and treatment, and the amount of the drugs administered, when a cure was effected, and when death followed respectively—

(i) Table of corpuscular elements in health. Horse—Mule—Donkey 48

(ii) Do. During treatment of Surra... 49

Summary of the number and ratios of the corpuscular constituents of the blood of Guinea Pigs, before and after inoculation with Surra blood, together with a table showing the results, when the paroxysms and intermissions are massed together—

Guinea Pig I. Table—Remarks 54

Do. II. Do. Do. 54

Table showing the number of hæmatozoa, red and white corpuscles, in each cubic millimetre of blood of rats and bandicoots, together with the animals' body weight, and that of the principal organs—

(i) Rats (Mus decumanus) 56

(ii) Bandicoots [Mus (Nesokia) giganteus] 56

Remarks on the changes observed with regard to the number of red, white and coarsely granular oxyphile cells (eosinophile cells) in the blood of animals—

(i) When Surra has been acquired naturally or by experimental inoculation 57

(ii) After unsuccessful inoculation with the bandicoot hæmatozoon 58

(iii) During the period of treatment of Surra with arsenic ... 58

Some notes on the amount of urea and hippuric acid excreted in the urine during health, and the phases of untreated, and treated Surra ... 58

Further notes connected with the etiology of Surra 60

ANNUAL REPORT FOR 1895.

Removal of goods to New Laboratory.

The packing of the scientific instruments and fittings of the Bacteriological Laboratory, Poona, was commenced in February 1895, and all the goods to the weight of 30 tons, were despatched by rail to Kathgodam *vid* Bareilly by the middle of May 1895. On the arrival of goods at Kathgodam Railway Station, they were transported by bullock cart to Bhowalie, the nearest point to Muktesar (19 miles distant) on the Kathgodam-Ranikhet Road. At this point, under the superintendence of Mr. Bamber, Clinical Assistant, a number of the larger boxes were repacked—in order to reduce their bulk—on account of the inadequate supply of coolies for the necessary transport of larger cases. Consequently the carriage of goods to the site of the present laboratory at Muktesar was not complete until the end of the year 1895, and even then several of the heavier items still remained at Bhowalie, until a sufficient number of coolies could be collected for the purpose.

During the year our time has been occupied, (i) in further investigating into the etiology and treatment of Surra, (ii) in preparing Volume II of the Surra Report for the press, (iii) arranging the mass of material for Volume III, (iv) in preparing for this Report a summary of the result of the most important physiological and pathological problems worked out in Poona, concurrently with the treatment of Surra during the years 1893—95. Further, a report has already been submitted in January 1896, recording the results arrived at during the outbreak of Surra and Filariasis at Karnal Remount Depôt in December 1895.

Surra in Camels.

Up to the present time I have observed Surra in equines and bovines, but have had no opportunity of observing the course of the disease in camels. I would, therefore, bring to your notice the desirability of my being informed of any outbreaks, which should happen to occur during the next 12 months in the last named animals, either in Rájputána, the Punjáb or North-West Provinces, so that I may be enabled to make a careful examination of the blood parasite, and if possible try the efficacy of treatment by arsenic.

Suggestion as to the issue of lantern slides to Veterinary Colleges.

When investigating a malady, it is our custom to prepare photographs of the animals attacked at different stages of the disease, together with micro-photographs or drawings of the chief pathological changes and organisms found in the blood and tissues. I would suggest that another and practical use might be made of such photographs and drawings, other than for reference and diagnostic purposes in future outbreaks. As results are obtained, lantern slides might be prepared at the Laboratory, and sets distributed to each Veterinary College in India and Burmah, to be used for purposes of demonstration in the lectures to students on bovine and equine medicine and pathology.

When a teacher wishes to demonstrate some particular disease to his class of students, it frequently happens that the necessary patients and pathological material are not forthcoming, or may be altogether impossible to obtain. Furthermore, the difficulties of preparing such specimens render it impossible for most Professors to find the necessary time, even if appliances are to hand.

A lantern and apparatus would have to be issued to each college, and one or more teachers would have to acquire the knowledge of how to handle it; but since the eminently practical paper by Colonel T. Deane, No. 28D., A. R. D., dated 19th August 1895, entitled "Optical lantern apparatus for the instruction and amusement of the Troops in India, and elsewhere," in which he points out that with the 'Saturator system,' of comparatively recent invention, practically small lime light lamps can be obtained, so simple in construction, that any person with a few hours' practice can easily work them, and that the higher the temperature the better they work. The working cost would be about three shillings and seven pence per hour of exhibition, including lime, gas and ether.

The initial cost of the necessary apparatus, including single mahogany triple rack lantern, very best make, 4½ inch condensers, with all the accessories would amount to £ 48-6-6 for each station.

I submit the above scheme for the consideration of the Government of India, and the necessary sanction should it be deemed advisable.

Tsetse Fly.

A subject of considerable interest was initiated by a correspondence between the Honourable the Secretary for Zululand, South Africa, and the Secretary to the Government of India, Revenue and Agricultural Department, dated 27th February 1895, in which the former reported "that investigations were being made by Surgeon-Captain Bruce, A.M.S., as to the so-called Nagana disease, a fatal disease which attacks horses, cattle, and dogs in certain parts of Zululand, and the disease supposed to arise from the bite of the Tsetse fly, which appears, so far, to be identical with Nagana." "The investigator was led to believe, so far as his researches had proceeded, that the disease might also be identical with 'Surra,' which is at present under investigation by Dr. Lingard on behalf of the Government of India." Reports and drawings which would enable Surgeon-Captain Bruce to identify the disease, were asked for, and a water colour drawing of the parasites found by the above officer in the blood of animals suffering from Nagana, and in the blood of animals known to have been bitten by the Tsetse fly, were forwarded (No. 519 M.) for inspection and report.

In my letter No. 121, dated 16th May 1895, I reported as follows:—

"The organisms depicted in Surgeon-Captain Bruce's drawing are infusoria—flagellated protozoa, and appear to correspond somewhat closely with the organisms found in the circulation of animals (elephant, camel, horse, mule, ass, bovines and dog) in India and Burmah, suffering from Surra; and in the bandicoot [Mus (Nesokia) giganteus] and rat (Mus decumanus), but in these two latter the hæmatozoon rarely produces fatal results. There are some slight differences between the Indian and South African species of Trypanosoma In this country, this protozoon varies in length according to its species. I have discovered some seven or eight varieties in different animals, but although variable in size, form, &c., in all the longitudinal or dorsal undulating membrane is well marked. In the drawing of Surgeon-Captain Bruce the longitudinal membrane is folded over at places, so that it is not seen in its entirety."

Looking up the only literature I had on the subject, I found that "the Tsetse fly (*Glossina morsitans*) is not much larger than the common horse fly, and the 'zimb' of Abyssinia is supposed to be identical with it, or a similarly venomous dipterous insect. The former is described as brown in colour with four yellow bars across the abdomen, and the bite is said to be almost certain death to horse, ox, and dog, but harmless to mule, ass, goat, and apparently to antelopes and other wild animals of the country. The ox after being bitten by the Tsetse fly, in a few days, or it may be even months after, shows the following symptoms:—A discharge runs from the eyes and nose, the coat stares, swelling under the jaw, sometimes in the region of the navel—emaciation, flaccidity of the muscles ensue, followed by purging, and sometimes staggering and madness, finally death."—*Chambers' Encyclopedia.*

My remark on this extract from the encyclopedia was "if the above description of the disease is a true account of what actually takes place in South Africa, the results materially differ from those observed in mules, asses and bovines affected with Surra in India and Burmah, Tonquin (China), and other countries in the East. Surra, (when untreated) in India and Burmah, according to our present experience is an absolutely fatal disease to all animals with the exception of bovines, *viz.*, horse, mule, ass, dog, goat, camel, elephant? rabbit and guinea pig, and although during the paroxysms of the disease, the blood of the bovine species teems with the hæmatazoon, and their bodies become extremely emaciated, nevertheless ultimately they recover and in time become fat and sleek again."

Three species of flies have been observed to infest animals, the subjects of Surra:—

(i) Called by the Punjabis the "Burra Dhang."

(ii) A gad fly, common during all months of the year.

(iii) A large brown-headed fly, seen only during the rainy season, the mandibles of this fly being adapted for piercing the skin, as it lives by sucking blood.

On several occasions in different outbreaks I have demonstrated microscopically the *Trypanosoma Evansi* in their blood. The most frequent fly found on equines is a kind of gadfly; the one infesting the dog appears to be a small variety of the same species.

A collection of the different flies found infesting Surra animals in this country is being made, and will probably appear in Volume III of the Surra Report.

I suggested that Surgeon-Captain Bruce be asked, when opportunity offers, to examine microscopically the blood and body fluids of the Tsetse fly for the presence of parasites (Trypanosoma, Nematodes, &c.)—

(i) When the fly is caught on the affected animals.

(ii) In its natural or wild state, and further that he may be allowed to correspond directly with me on points of interest connected with the elucidation of this disease in the two continents.

The following enclosures were despatched with the above letter;—

(i) Photograph of Horse No. LXXXIX, Australian, pulled down by Surra.

(ii) Do. do. six months later.

(iii) Do. do. one year after Surra, *cured*.

(iv) Do. Horse No. CXV, country-bred, after *cure* affected.

(v) Do. do. CXIX, Herati, during convalescence.

Drawings—

A. Trypanosoma in blood of Rat (*Mus decumanus*).

B. Do. do. Cat.

C. Do. do. Horse.

D. Do. do. Guinea Pig.

E. Do. do. Bovines.

F. Tsetse fly.

G. Drawing of flies caught on the body of a Surra Horse, and Dog.

H. Photos of flies from Surra Horse.

Government of India forwarded Volume I, Surra Report, and Summary for 1894.

In September 1895, Summary forwarded for 1895.

In a letter dated 15th September 1895, Ubombo, Zululand, received 7th November 1895, Surgeon-Captain Bruce says;—

"We want to establish the identity of the fly disease with Surra, or the want of identity, and for this purpose I propose to send you cover glass preparations of the blood from various animals, stained and unstained, and an account of the symptoms of the disease in the same animals. I shall also send you specimens of the Tsetse fly, which may or may not have some connection with the propagation of the disease."

"In this country an important point to settle is whether or not any of the wild animals help to spread the disease. Because there is a very widely spread idea among the natives and white settlers here, that some of the big game, such as buffalo, wildebeeste, rhinoceros, koodoo, water buck, have in some way or other a connection with the disease. They say, drive out the big game, you drive out the disease; allow the big game to increase, the disease increases."

Blood specimens of the Trypanosoma taken from the cow, dog and donkey were also received.

On my return from Karnal, Punjab, in January 1896, I carefully examined the above microscopical specimens, and expressed my opinion at some length on this and other questions raised, in a letter despatched on 16th February 1896 to this effect:—

"That the flagellated protozoa found in the Nagana and Tsetse blood disease, correspond exactly (as far as I am able to judge, microscopically) with those found in the blood of animals the subjects of Surra in India."

"In my observations at Karnal, December 1895, I had seen two large Hissar bullocks, the subjects of Surra complicated with severe intermittent fever and the presence of the embryos of the 'Filaria papillosa' in the circulation. One of these bullocks, with a daily range of temperature amounting to 10° F., had succumbed to the combined diseases, but the other was still alive, and at this date (May 1896) has regained its health and is in good condition."

20th April 1896.—Received copy of "*Preliminary Report on the Tsetse Fly Disease or Nagana, in Zululand,*" by Surgeon-Major David Bruce, A. M. S., dated Ubombo, Zululand, December 1895.

From the above report it appears that the fly disease "is invariably fatal in the horse, donkey and dog, but a small percentage of cattle recover." Contrary to the experience of observers in India, the African disease "is characterized by the *constant* occurrence, in the blood, of an infusorial parasite, either identical with, or closely resembling the *Trypanosoma Evansi.*" The marked feature in the Indian disease being the presence of *paroxysms* and *intermissions*, during which periods the Trypanosoma is present and absent respectively.

In some few cases in horses the paroxysms in India have been observed to last 18 to 22 days, but these have only occurred in experimental animals.

With regard to the action of arsenic, Surgeon-Major Bruce observes:—

"It appears, however, that arsenic has a specific action; causing the hæmatozoa to disappear from the blood, to hinder or prevent the blood destruction and emaciation, and modify the temperature curve. Whether this drug will completely cure the disease or not, remains to be proved, but that it can hold it in abeyance is seen from the chart. The horse I have had under arsenic has very fairly retained his strength, as may be proved by the fact that he has very regularly of late carried me down to the fly country and back every second day, when I have gone down to collect flies. This means being on the march from 5 A.M. until 5 P.M., with a climb in the afternoon of the Ubombo, which is said to be 2,000 feet above the plain."

I have thought it necessary to record these facts somewhat fully, on account of the premature announcement made by Surgeon-Major Bruce in his report as to the views held by me with regard to the Tsetse fly disease, and previous to my examination of his specimens of Surra blood.

Herewith are enclosed three appendices—

(i) Journal of journeys undertaken during 1895-96.

(ii) Précis of the recorded outbreaks of Surra during 1895-96.

I wish to draw special attention to the reports forwarded to this office by Veterinary Captain H. T. Pease, on the prevalence of Surra in the Punjab and North-West Provinces during the past season; for it is only by such careful and painstaking work that we can hope to gain further knowledge with regard to the true nature of the prevailing diseases, and the geographical distribution of the same, in India and Burmah.

(iii) Appendix containing a short statement of the results of physiological and pathological observations with regard to equines, &c., in health and disease. These researches were initiated in 1893, and have been worked out concurrently with the treatment of animals whenever circumstances permitted. The object in view was to elucidate the changes which take place in the blood of animals previous to and after contracting Surra, together with an enquiry into the ingested and egested nitrogen and water for the purpose of explaining the rapid waste of tissue in this disease.

To Mr. M. K. Bamber, Clinical Assistant to the Imperial Bacteriologist, who has rendered most valuable assistance in every part of the inquiry (Appendix III), my special thanks are due.

APPENDIX I.

JOURNAL OF JOURNEYS DURING 1895-96.

21st May 1895.—Left Poona and arrived in Bombay—

(i) Business with the Superintendent, Government Central Press, regarding printing Volume II of Surra Report.

(ii) To obtain information concerning outbreaks of Surra from the Manager, Bombay Tramway Company.

(iii) To order articles for use at the New Laboratory.

29th May 1895.—*Left Bombay*—

To join at Muktesar.

1st June 1895.—Inspected some 30 tons of Laboratory goods which had arrived at Kathgodam.

4th June 1895.—Arrived at Muktesar, Naini Tal District, North-West Provinces.

23rd Oct. 1895.—Proceeded to Kathgodam to examine a number of Surra horses and obtain material for work. To Bareilly to obtain small animals, and make arrangements for future supply.

6th Dec. 1895.—Proceeded to Karnal to investigate outbreak of disease amongst remounts at Government Depôt, then visited Saharanpur Depôt to inspect four cases of paralysis, and arrived at Muktesar, 7th January 1896.

APPENDIX II.

OUTBREAKS OF SURRA DURING 1895-96.

PUNJAB.

Dera Ismáil Khán District.

In August 1895 Surra, vernacular, "Sár," occurred in the village of Shah Doad, three horses dying out of a total of seven. Two horses also died from "Kamri," paralysis. The former disease is also well known in the following low-lying villages:—Budhani, Hussain, Saghar, Lack, Dhotra, Saidhowali, Dhap, Kalakhor, Dhala and Balwagi.

Sialkote District.

Surra occurred in the following villages of the Sialkote District in November 1895:—

Tahsil Sialkote, village Salimpur.

Tahsil Zafarwal, village Chonda.

Tahsil Pasror, village Jhalki.

Amritsar District.

During the rains of 1895 Surra occurred in the following villages of the Ajnala Tahsil, *viz.*, Jastarwal—15 horses died, Muhallawala and Warengi. These villages are said to be low-lying and subject to inundation. The people of the district appear to have an idea that the disease is new; it is not widelyknown, but is often named "Gum-zahrbad."

Gurdaspur District.

Surra, vernacular names, Khusk-zaharbad and Sôkra, is reported to have occurred in twelve villages in this district, five of which are situated in the Pathankote Tahsil. The cases occurred between October and December 1895, and the position of the affected villages is described as low-lying and subject to flooding.

Ludhiána District.

In 1894 Surra occurred in four villages in the above district, *viz.*, Bahaival, Bawan Kalan, Buwan Khura and Staria. These villages are situated in the 'Bet,' a very unhealthy portion of the district, low-lying and alluvial, subject to inundation from the river Sutlej and the Badha Nála.

Patiála State.

The disease also appeared in the Rákh, which is situated in that northern portion of the Patiála territory which juts into the Ludhiána District.

Jullunder District.

Jullunder Tahsil.—In 1894-95 the names of 10 villages are specified, and Surra broke out in three other villages at the commencement of 1896.

Dasaya Tahsil.—In 1894-95, 20 villages are specified as having lost the majority of their animals, and in one, Sosyan, 36 horses succumbed to Surra. It is said, however, that the disease appeared in nearly every village in the tahsil.

Hoshiárpur and Jullunder Districts, 1895-96.

Surra, the vernacular names for which appear to be 'Tap,' 'Sokhra,' 'Zahrbad,' 'Tapdik,' is said to have been very severe in these districts. The people say that the disease spread from them to the 'Bet' villages.

Umballa District.

Pipli Tahsil.—Surra made its appearance in the rains of 1894, and at the village of Looki four horses and eight asses died. During the wet season of 1895 the returns made, included 15 villages, in one of which, Bhoosthala, all the solipeds succumbed to the above disease. As far as could be ascertained, the other tahsils, *viz.*, Jagadhri, Kharer and Náráingarh, are freer from Surra than the southern part of the Pipli, which is swampy and subject to flooding during the monsoon.

In 1895 Surra occurred in 21 villages in this district which lie, for the most part, between the Western Jumna Canal and the Jumna River. The tract is seriously water-logged and swampy, 'kadir,' owing to percolation from the canal. Gogpur and Salpani Kalan are on the banks of the Markanda, and are subject to inundation in the rains. Omree is on the Grand Trunk road and is subject to inundation from a small branch of the Ghittang River. The losses have been serious in all, but some of the villages have been practically cleared out of soliped animals.

1896, *Umballa.*—By order of the Deputy Commissioner, two camels belonging to the Police, and suffering from Surra were destroyed.

Karnal District.

"Pheta" (Surra) caused its ravages during the rains of 1895 in 72 villages visited by Veterinary Captain Pease. The disease occurred in many other villages, especially in those in the Khadir (132 in number) and Naili (64 in number) where it is said to occur annually; but as so few horses are kept, the donkey and ponies belonging to the Kumhárs (potters) only are attacked, and their loss does not attract much attention. The losses from Surra in sixteen (16) villages in the above tahsil, when statistics were forthcoming, are as follows:—

Animals.	Horses.	Mules.	Asses.
Total number kept	220	55	281
Number succumbed	106	22	125
Percentage of deaths	48·18	40·00	44·48

Many of the villages lost, in addition, a great number of their dogs from this disease; in some there was scarcely one remaining. The canines appear to have contracted the malady through eating diseased carcases.

It was thought to be more than likely, that the villages in the Indri and Pipli tahsils, sustained severe losses from the same causes as the above mentioned—the former lying between the Western Jumna Canal and the Jumna River, the latter on the border of the Amballa. Surra is known to be enzootic in the latter locality.

Surra has been most prevalent in the north-east corner of the Kurnal District, part of the Kurnal Tahsil lying in the angle formed by the Umballa-Kurnal and Kurnal-Meerut roads, that is between 77° and 78° Longitude, and 29° 50″ and 30° N. Latitude.

In this locality alone no less than 101 villages are known to have suffered very considerable losses. The general opinion however is, that nearly all the villages in this tahsil have suffered more or less from the ravages of this disease.

Delhi District.

Surra (Zahrbad) occurred in seven villages of the Sonaput Tahsil situated in the Jumna Khadar during the latter half of 1895. The following native remedies were tried, but none of the drugs had any curative effect:—Zirisiah, Zirisafaid, Sohaza, Sajji, Phatkari, Hing, Nimak Lahori, Nimak Sambhar, Kalonji, Goor, Ajwain, Khursani, Ajwain desi, Ajwain babayl, Gund, Peepla mul, Kali mirch, Surkh mirch, Darchini, Gundak. Purgatives were also tried.

Balabgarh Tahsil.—In Kurnali, which lies near the Jumna, Surra appeared in the rains of 1893, and killed off all the horses and asses in the village. Since then no equines have been kept. The Lambardár lost four horses, for which he had paid Rs. 250 each. Enquiries with regard to the disease are being made in the villages near the river, and also in those lying in the vicinity of the Najafgarh jheel.

NORTH-WEST PROVINCES.

Saharanpur District.

Statistics were obtained from fifty-three (53) villages in the Nakur Tahsil, and in three other *gaons*, Surra was known to have been present after the rains (November 1895), *viz.*, Khoona, Childána, and Dánápur, but no numbers were obtainable.

Later returns show that, in addition to the above-mentioned outbreaks, Surra also occurred in eight villages, during November and December, in the Deoband Tahsil, in six during September and October in the Roorki, in 22 during January in the Nakur, and in nine villages during August to December in the Saharunpur Tahsil :—

Animals.	Horses.	Mules.	Asses.
Total in 53 villages	578	208	804
Succumbed to Surra	309	98	502
Deaths percentage...	53·46	47·11	62·43

Saharanpur and Rajpur Dák Line.

Surra appeared amongst the animals on this line during, and subsequent to, the rains of 1895. A total of 56 horses succumbed to the disease, 44 of which were stationed in the Mohund Pass ; of the remaining 12, six ran on the Saharanpur side, and six on the Rajpur side of the Pass. (*Loughlin.*)

Muzaffarnagar District.

During the rains of 1895, 16 villages are reported in the Kairana Tahsil as having been the seats of Surra. Twelve out of the 16 are said to be low-lying and subject to inundation ;—

Animals.	Horses.	Mules.	Asses.
Total in 16 villages	231	58	547
Number succumbed to Surra	68	8	242
Deaths percentage	29·43	13·79	44·24

Meerut District.

Surra was prevalent amongst the camels in the village of 'Naoni' in the Gaziabad Tahsil of the Meerut District in October and November 1895. This village is situated in the Jumna Khadars, and although the village itself lies very high, the surrounding land is flooded in the rains. There are between 200 and 300 camels in the village, and of these 30 or 40 had died, when the report was made, out of 60 odd attacked. This disease is well known to the people as 'Phitgya' or 'Purana.' They do what they can to avoid it by driving camels away to the Bangar lands in the rains, and watering those which remain at wells only during the rainy season. They attribute the disease to tank or stagnant water, and do not water their animals at open places until the water has stood for a considerable time and become 'pakka.' They consider that the disease is very contagious. The diagnosis is most surely made by the smell of the urine, which becomes very offensive. There are paroxysms, during which the animals do not feed, and free periods.

The disease often runs its course very slowly, lasting for years. Sick animals are isolated from healthy ones.

Balandshahr District.

Surra occurred in the village of Rahbopura, in the Sikandarabad Tahsil of the Bulandshahr District, in 1892. This village is in the Jamna Khadars, about four miles distant from the river, and is subject to inundation. It is a Bilooch village and the people used to keep numbers of camels. There were about 400 there in 1892, but the whole of these animals died between the rains of that year and 1894. The following villages, which were inhabited by camel-men, have also suffered very severely from the disease :—Thagghar, Tahangerpur

Malerna, Kákur. These villages used to be full of camels, but few remain at present, and many of the people have been ruined from the losses caused by this disease. The country is reported to be water-logged and subject to 'reh.'

1893. *Fyzabad District.*

Surra occurred in the 3rd Bengal Cavalry, stationed at the Fyzabad Cantonments, in October, November, December, 1893. Fyzabad is low-lying on the banks of the Sarjoo River, which inundates the country up to the cavalry lines in the rains. The disease is said to have first appeared in a squadron of horses, which were out on duty during the rainy season in the Azamgarh District, at Jhaj-man. Many of these died, and the disease also appeared in the horses of the remainder of the regiment. One hundred and fifty (150) horses succumbed to the disease. Surra is said to have also caused considerable loss in 1894. The probable reason, the horses which had been out on duty in 1893 were first attacked, is that they were weakened by exposure to the climate in the rains, and so fell victims to the disease earlier than the others.

1895. *Naini Tal District.*

At Kathgodam, the R. and K. Railway Tonga service lost eight (8) horses in the rains, private owners of riding and ekka ponies losing sixteen (16).

1895. Bombay Presidency.

Bombay Tramway Company.

The last case to occur during the season of 1894-95 was on January 21st. No further animals were attacked until the rains were well advanced, *viz.*, September, when six horses were destroyed, two in October, three in November, three in December, and two in January 1896. After this the disease stopped. Of the total of 16 horses which succumbed to 'Surra,' 12 were Australians, varying in age from 6 to 21 years—average 9·7 years, and the remaining four were country-breds, varying in age between 6 and 10 years—average 7·75. (*Rimington.*)

1895. *Bombay City.*

Over a dozen animals suffering from Surra were taken for treatment to the Bái Sakarbái Hospital for animals. (*Pease.*)

1895. *Broach District.*—Hunsot Mahál.

At the village of Digas, Surra, locally termed 'Berbag,' appeared on the 22nd October 1895. The native treatment adopted, was to administer chillies and the juice of Pindoli to the sick horses. Four animals had succumbed, and one was under treatment at the time that the report was furnished. (*Pease.*)

Burmah.

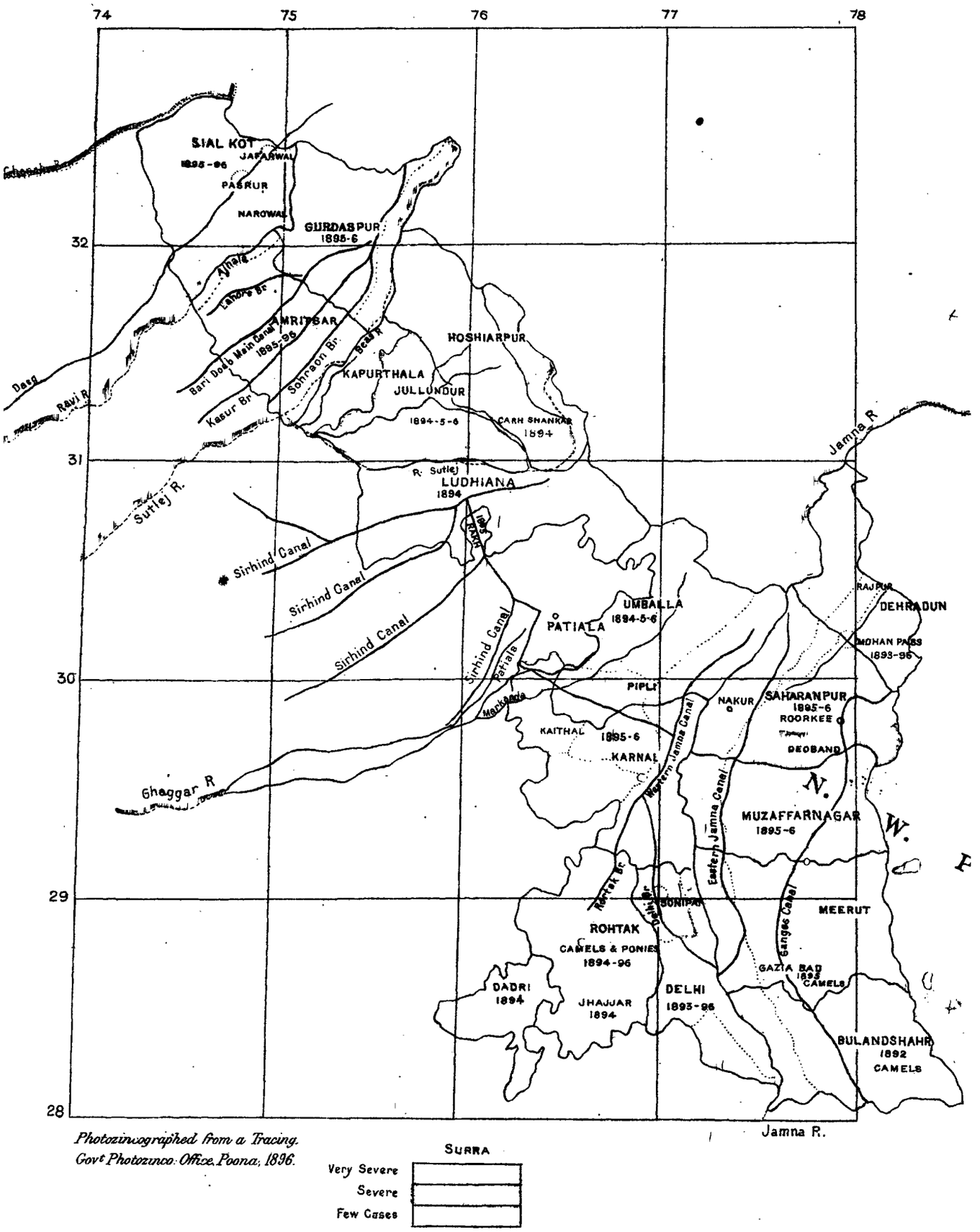
Memorandum showing the casualties of Transport animals (Mules and Ponies) in Burmah due to Surra from 1st April 1895 to 30th June 1896.

Stations.	1895.									1896.						Total.	Remarks.
	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.		
Meiktila	...	...	...	12	35	26	1	2	...	...	...	...	...	...	...	76	
Fort Stedman	...	...	...	...	...	...	...	...	2	2	...	...	...	...	1	5	Elevation 3,000 feet.
Mandalay	1	...	2	6	19	14	10	3	6	2	4	1	4	3	33	108	July 16 1896 Surra now prevalent amongst Transport animals.
Phabeikkyin	...	...	...	...	...	...	...	...	...	...	...	...	...	1	9	10	
Shwebo	...	...	...	...	...	1	2	2	10	4	...	...	...	1	...	20	
Bernardmyo	...	1	...		1	7	8	9	16	4	3	...	...	...	...	49	Elevation 6,000 feet.
Myingyan	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	2	
Kalewa	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2	
Haka	...	...	1	...	...	12	18	17	...	...	...	...	...	...	...	48	Elevation 6,000 feet.
Falam	...	...	...	...	7	6	24	9	...	...	...	...	...	...	...	46	„ 6,000 feet.
Total ...	1	1	3	18	62	68	63	44	34	12	7	1	4	5	43	366	

MAP

showing certain districts of Punjab & North Western Provinces where Surra out-breaks have been prevalent during the years

1894—1895—1896



Photozincographed from a Tracing.
Govt Photozinco. Office, Poona, 1896.

SURRA

Very Severe
Severe
Few Cases

Statement showing number of Ponies of the Military Police that died from "Surra" as below.

Stations.	1894.	1895.	Rainfall.	Remarks.
Mandalay	53	2	MuchRain ...	July 16th, 1896.—Surra now prevalent amongst the Commissariat Department Transport animals: seventy have succumbed already, many others dying.
Bhamo	1	...	Ditto.	
Mogaung	6	23	Ditto.	
Katha	25	26	Ditto.	
Mogôk	3	3	Ditto.	
Lashio	5	...	Dryer.	
Mônywa	25	9	Dryer.	
Yamethin	9	3	Dry.	
Pyawbwe (Yamethin) ..	16	19	Dry.	
Shwebo	5	1	Dry.	
Meiktila	2	30	Dry.	
Pokakku	1	...	Dry.	
Magwe	4	6	Dry.	
Gangaw (Pakokku)	...	2	Much Rain.	
Myitkyina	...	21	Ditto.	
Pymmana (Yamethin) ...	...	42		
Pegu	...	12		
Total ...	155	199		(Veterinary Captain G. H. Evans)

REMARKS.

It will be observed, on reference to the accompanying map, that Surra has been found to be prevalent, in different degrees of severity, in ten districts of the Punjáb, and the five bordering districts of the North-Western Provinces, those in which enquiries have been made by Veterinary Captain Pease up to the present date. No information has been recorded of an earlier period than 1892, and in most instances the reports deal with outbreaks which occurred between the years 1894 and 1896; consequently the data are reliable. During the past season, the above officer has been able to examine microscopically—on the spot—the blood of diseased animals; and having observed the *Trypanosoma Evansi* in numerous cases, has consequently settled the question of 'diagnosis' once and for all.

Surra is undoubtedly very widespread in this part of the continent of India, and if we are to judge the total losses in these provinces during 1895, by the returns of a number of villages where statistics have been forthcoming, the ravages of this disease in horses, mules and asses have been truly appalling. The only recorded outbreak of such magnitude, which can be compared to the above, was a widespread one which occurred during the rains of 1893 and 1894, in the Gujarát, Ahmedabad and Baroda districts, involving an area of some 400 square miles, and occasioning the loss of thousands of horses, ponies, camels and asses.

Portions of Veterinary Captain Pease's report on Surra in the Kurnal District are equally applicable to other districts in the Punjáb and North-Western Provinces. I cannot therefore do better than quote certain passages in this officer's own words.

(i) *Recognition of the disease by the natives.*—"The simple fact of its being so well known to every one in the place who knows anything about horses, and indeed to the majority of people, who have little to do with these animals, points to its extensive ravages and general distribution: for it is not a very usual thing for the people to have the symptoms of a disease at the tip of their tongue, and in this place, I do not think I ever asked anyone whether they knew anything about it, without receiving an answer in the affirmative."

(ii) With regard to the *season of occurrence*, "the disease is purely one of the 'chaumasa' or the rainy season. It generally occurs after a considerable quantity of rain has fallen, and the country has been flooded for some time, and new grass has sprung up. It commences to show itself most commonly towards the end of August, and remains prevalent in horses until the middle of December. It continues longer in both mules and donkeys, and I found numerous cases still going on late in January."

(iii) *Geographical distribution.*—"The distribution of this malady seems to be entirely influenced by the physical aspect of the country. It appears to be chiefly influenced by the occurrence of floods and inundations, being far more prevalent in those parts of the

country where these occur, than in the higher and drier portions. It is far more common in the vicinity of the rivers and canals, than it is in the dry portions of the Nardak, for example....."

On reference a second time to the map, we note that the most striking Surra area in the south is that bordering on either side of the river Jumna, extending for a varying distance to the east and west of it respectively. In addition to this tract being subject to annual inundation during the rainy season, it is water-logged from the river overflow water, and soakage also takes place on the western side from the Jumna Canal and its branches, while on the eastern side, the canal (East Jumna) is at fault.

In the Pipli Tahsil of the Umballa District, we found the Markanda River running from north-east to south-west, and the Sirhind and West Jumna connecting canal crossing it in the opposite direction. A portion of Patiála State jutting into the Ludhiána District, which tract is called the 'Rakh', is watered by a branch of the Sirhind Canal.

The Jallundhar and Hoshiarpur districts would not appear to be inundated to the same extent that many others are; the southern limit of the former, however, is subject to flooding by the Sutlej, and the north-east and south-east boundaries of the latter are similarly affected. These tracts are nevertheless reported to be subjected to very severe outbreaks of Surra.

The information received with regard to Surra in the Sialkote, Gurdaspur, and Amritsar districts, is as yet limited, but what is known points to the fact that the disease is more sporadic in character, and the outbreaks more circumscribed.

APPENDIX III.

PHYSIOLOGICAL AND PATHOLOGICAL PROBLEMS IN EQUINES DURING HEALTH, AND THE PHASES OF SURRA.

In investigating the experimental treatment of Surra, the opportunity was taken of working out certain physiological and pathological problems as far as circumstances would permit. In order to make this enquiry in equines (horses, mules and donkeys), the quantity and composition of the ingesta and egesta have been ascertained during a period of health—previous to inoculation,—the incubatory period of the disease, and the paroxysms and intermissions, until death. The weight of the animals under experiment was ascertained at frequent intervals.

The following data were recorded, *viz.*;—

The weight and composition of the *Ingesta* including corn, hay and green fodder, and water; also that of the *Egesta* including dung and urine.

In the case of Horse No. LXXXIX (2nd Series) the dung was weighed and the urine measured three times during the twenty-four hours (noon to 6 P. M., 6 P. M. to 6 A. M. and 6 A. M. to noon), in other cases once daily. In the urine, the total nitrogen, the urea, hippuric acid, ammonia and albumen were separately estimated.

A.—Untreated Cases of Surra.

Horse No. XCII.

Grey country-bred, aged. Height 15 hands. Body weight 755 lbs.

The investigations were carried on for ten days previous to inoculation with Surra. The incubation period occupied six days; there were five paroxysms occupying 28, varying in length from one to 10 days each, and four intermissions lasting six days.

The following are the chief points to be noted—

Urine.—The small average quantity of urine passed daily during the whole case, *viz.*, 1,599 c.c. The average daily quantity in the paroxysms was 1,632 c.c., and during the intermissions 1,962 c.c., an increase in the latter period of 330 c.c.

Urea.—The average amount of urea excreted daily during the period of observation 10 days, was only 17·68 grammes, *i. e.* less than $\frac{1}{3}$th of the normal amount stated to be passed by English cart horses. This amount was slightly increased in the latent period (23·25 grammes). In the paroxysms the urea rose to an average daily of 61·08 grammes, whilst in the intermissions it reached 79·89 grammes.

Hippuric Acid.—A normal quantity was excreted during the periods of health, latent period and paroxysm I. In the intermission following it ceased, and only small quantities occurred during the rest of the case.

Albumen.—Small quantities appeared in the urine at intervals during the case, the largest amount 3·456 grammes being present in the fifth and last paroxysm.

HORSE XCII. *Table I showing the mean daily averages, with ratios in health and disease (Surra), of the Urine and its constituents, &c.*

Periods.		Health.	Latent Period.	Parox I.	Interm. I.	Parox. II.	Interm II.	Parox. III.	Interm. III.	Parox. IV.	Interm. IV.	Parox. V.
Days.		0	6	1	1	8	2	6	2	3	1	10
	Quantity.											
Urine	c.c. ...	1,489	1,271	1,560	1,280	1,387	2,275	2,233	2,200	1,740	1,540	1,441
Ratio		**1**	**0·85**	**1·04**	**0·86**	**0·93**	**1·53**	**1·50**	**1·47**	**1·16**	**1·03**	**0·97**
Urea	Grammes ...	17·68	23·25	46·80	42·88	47·85	100·52	73·05	81·24	63·79	72·92	66·80
Ratio		**1**	**1·32**	**2·64**	**2·42**	**2·76**	**5·68**	**4·13**	**4·59**	**3·60**	**4·12**	**3·77**
Hippuric Acid	Grammes ...	7·88	12·22	10·92	0·00	0·26	0·00	4·18	2·20	0·00	0·00	0·15
Ratio		**1**	**1·55**	**1·38**	**0**	**0·03**	**0**	**0·53**	**0·28**	**0**	**0**	**0·01**
Ratio ... Urea to Urine ...	1 : ...	84·26	54·66	33·33	29·85	28·99	22·63	30·57	27·08	27·31	21·12	21·57
*Albumen	Grammes ...	0·086	0·070	...	...	0·599	0·084	0·297	...	0·202	0·086	3·456

*Total quantity for each period.

Horse No. XCIII.

Bay Australian gelding, aged 7 years. Height 15 hands. Body weight 780 lbs.

This experiment was undertaken with a view to determine the class of disease, when communicated from a dog suffering from naturally acquired Surra.

Daily observations were made regarding the output of urine, urea, and the amount of water drunk.

The following are a few of the most important points observed:—

Urine.—The average quantity (2,490 c.c.) passed daily in health was only about one half the normal output for English horses at rest (F. W. Smith); this increased during the latent period to an average of 2,989 c.c. A marked increase occurred during the six paroxysms, lasting 20 days, in the course of the disease; in the first, the daily average was 4,525 c.c., and in the sixth and last 9,123 c.c., giving a mean throughout of 7,452 c.c., 2·99 times the quantity in health. In the six intermissions lasting 15 days, the daily average was 5492 c.c., this being 2·18 times as much as in health.

Urea.—As in the urine, the amount of urea during the periods of health and incubation was only $\frac{1}{2}$ the normal output in English horses. In the paroxysms it was 99·82 grammes or over double that of the health period; this amount, however, is only equivalent to the average output in England (F. W. Smith). In the intermissions the output of 68·98 grammes was only $\frac{7}{10}$ths of the paroxysmal quantity.

Hippuric Acid.—A small quantity of hippuric acid was passed during the latent period, and a trace during the second paroxysm; for the remainder of the disease none was passed.

Albumen.—No albumen was present in the urine during health, but a trace appeared in the latent period, and at intervals during the remainder of the case; a total of 3·364 grammes being excreted.

DOG SURRA—UNTREATED.

HORSE XCIII. *Table II showing the mean daily averages, with ratios in health and disease (Surra), of the urine and its constituents.*

Periods.		Health.	Latent Period.	P^1	I^1	P^2	I^2	P^3	I^3	P^4	I^4	P^5	I^5	P^6	I^6
Days.		10	9	2	3	2	3	5	2	2	3	2	3	7	1
	Quantities.														
Urine	c.c. ...	2,490	2,989	4,525	40·93	4,315	6,280	6,860	5,700	8,720	5,443	7,885	5,800	9,123	5,150
Ratio		**1**	**1·20**	**1·81**	**1·64**	**1·75**	**2·68**	**2·73**	**2·28**	**3·50**	**2·18**	**3·16**	**2·54**	**3·66**	**2·06**
Urea	Grammes ...	46·64	44·24	51·61	77·88	20·05	87·74	88·91	33·05	88·15	63·58	128·22	71·87	139·39	65·40
Ratio		**1**	**0·94**	**1·10**	**1·66**	**0·43**	**1·88**	**1·90**	**0·70**	**1·88**	**1·36**	**2·74**	**1·54**	**2·98**	**1·40**
Hippuric Acid ...	Grammes ...	3·48	3·48	0·00	0·00	2·79	0	0	0	0	0	0	0	0	0
Ratio		**1**	**1**	**0**	**0**	**0·80**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Water...	Litres ...	17·80	18·55	21·23	18·75	20·66	19·63	17·87	23·22	29·92	20·00	18·52	22·60	20·83	6·84
Ratio		**1**	**1·04**	**1·19**	**1·05**	**1·16**	**1·02**	**1·00**	**1·30**	**1·67**	**1·17**	**1·04**	**1·27**	**1·17**	**0·38**
Ratio ... Urea ... Urine ...		1 : 53·38	1 : 67·5	1 : 87·7(	1 : 52·60	1 :215·2(	1 : 71·60	1 : 77·20	1 :172·50	1 :98·90	1 : 85·30	1 : 61·50	1 : 80·70	1 : 65·40	1 : 78·70
,, Urine ... Water ...		1 : 7·14	1 : 6·20	1 : 4·6(	1 : 4·58	1 : 4·79	1 : 3·12	1 : 2·61	1 : 4·08	1 : 3·48	1 : 3·83	1 : 2·34	1 : 4·30	1 : 2·28	1 : 1·32
Albumen	Grammes ...	...	0·150	...	0·189	0·170	0·839	...	...	...	...	...	...	1·729	0·285

B.—Treated Cases of Surra.

Horse No. LXXXIX.

Australian gelding, aged 16 years, body weight 1,028 lbs.

This experiment was undertaken with a view to elucidate whether an animal inoculated with Surra could be successfully treated, and during the progress of the case observations were made daily with regard to the output of Nitrogen as urea.

After the investigations had been carried on for six days, the animal was inoculated with Surra: the period of incubation occupied six days, and the first and only paroxysm five days. Treatment with arsenic (Liq. Arsenicalis) was commenced immediately on the appearance of the *Trypanosoma* in the blood, and was continued during 60 days, although no organisms re-appeared after the first five days of treatment, in which 50 grains of Arsenic were administered. At that date (61st day) the double Iodides of Arsenic and Mercury were substituted for the above. The iodides were administered for a period of one-hundred and six (106) days. As the organism of Surra had now been absent from the blood for a period of one-hundred and sixty-six (166) days, all treatment was discontinued, but the observations were carried on for a further period of two-hundred and twenty-six (226) days. For the last 26 weeks of the case—regarded as health—the total Nitrogen ingested and egested was estimated.

The chief points of interest in this case are:—

Urine.—The small quantity, *viz.*, 1,255 c.c., passed daily during the preliminary period of health; this quantity increased slightly during the period of incubation and still more during the paroxysm. Under the arsenical treatment it again decreased, average 1,543 c.c., but when the iodides were administered, the daily quantity was doubled—3,162 c.c., and still further increased after treatment ceased. The average daily quantity was now 4·8 times that of the preliminary health period.

Urea.—The amount of urea, as in the case of the urine during the period of health and incubation, was only one-fourth the normal output as found in England. It increased about 2·5 times in the paroxysm, but again diminished during the arsenical treatment. The effect of the double iodides was to rapidly raise the excretion of urea to 4·03 times that of the preliminary health period, and this elimination was still further increased to 4·43 times, during the subsequent period of non-treatment extending over 31 weeks.

Hippuric Acid.—The average daily output of hippuric acid, *viz.*, 11·08 grammes, in health, was increased during the latent period to 18·62 grammes; it fell to 12·49 grammes in the paroxysm, and rose again during the 60 days' arsenical treatment to 16·14 grammes. A great reduction to 2·18 grammes occurred during the administration of the double Iodides of Arsenic and Mercury, and none was excreted during the first 163 days after the iodides were discontinued, the excretion of the acid then recommenced, and for the last 63 days of the case the mean daily output was 14·87 grammes.

Table III.

Horse LXXXIX. *Showing the mean daily averages and ratios, in health and treated Surra, of urine and its constituents, &c., together with the water drunk.*

Periods.	Health.	L. Period.	Paroxysm.	Arsenic.	Iodides.	No treatment.	Whole Period.
Length in days.	6	6	5	60	106	226	409
Urine, c.c.	1,255	1,364	1,892	1,543	3,162	6,180	4,437
Ratio	1	1·08	1·50	1·23	2·52	4·92	3·53
Urea, grammes	21·42	19·71	52·90	28·71	86·53	94·93	80·33
Ratio	1	0·92	2·47	1·34	4·04	4·43	3·75
Hippuric Acid, grammes	11·08	18·62	12·49	16·14	2·18	days 163—*nil* 63—14·87	...
Albumen, grammes	...	0·052	0·157	0·233	1·105	3·645	5·194
Water, litres	14·44	13·87	15·96	17·18	18·06	18·78	18·19
Ratio urea to urine	1 : 11·50	1 : 10·16	1 : 8·43	1 : 11·13	1 : 5·71	1 : 3·12	1 : 4·09
Ratio urine to water	1 : 58·50	1 : 69·50	1 : 35·80	1 : 53·76	1 : 36·54	1 : 63·49	1 : 55·23
Arsenic, grains	...	...	50	368	...	...	438
Iodides As., grains	...	...	...	...	288	...	288
„ Hg. „	...	...	...	...	288	...	288

HORSE LXXXIX. 1st series (Health) (31st—56th weeks inclusive)—

TABLE IV.

Showing the total Nitrogen ingested and egested during 26 weeks observation after the successful treatment of Surra.

Date 1895.	Nitrogen ingested in food.					Nitrogen egested in urine, dung and sweat.					Difference between ingested and egested Nitrogen.	Equivalent to flesh at 1 Nitrogen = 30 flesh.	Body weight of animals.	Increase.
	Hay.	Lucerne	Barley.	Bran.	Total.	Urea.	Hippur. Acid.	Sweat.	Dung.	Total.				
Weeks.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1 ...	1·4000	·3710	1·4490	·3150	3·5350	·4065	...	·0658	1·9842	2·4565	+1·0785		851·8	
2 ...	1·9300	·3710	1·3041	·4250	4·0301	·4918	...	·0658	2·3727	2·9303	+1·0998			
3 ...	2·0200	·3710	0·7659	·9287	4·0856	·6062	...	·0658	2·7459	3·4179	+ ·6677			
4 ...	1·9500	·3710	1·4490	·3325	4·1025	·5997	...	·0658	2·5395	3·2050	+ ·8975			
5 ...	2·0500	·3710	1·4490	·3325	4·2025	·7420	...	·0658	2·2351	3·0429	+1·1596			
6 ...	2·0300	·3710	0·6624	1·0650	4·1284	·6080	...	·0658	2·4644	3·1332	+ ·9952			
7 ...	1·8700	·3710	0·0370	1·4250	3·7630	1·0457	...	·0658	2·0808	3·1923	+ ·5707			
8 ..	1·8200	·4240	0·0000	1·0500	3·2940	·6892	...	·0658	2·3435	3·0985	+ ·1955			
9 ...	1·6900	·3710	0·2898	1·0500	3·4008	·5825	...	·0658	2·4853	3·1336	+ ·2672			
10 ...	1·9300	·3710	0·5382	1·0500	3·8892	·5923	...	·0658	2·7814	3·4395	+ ·4497			
11 ...	1,9000	·3710	·5796	1·0500	3·9006	·6378	...	·0658	2·6521	3·3557	+ ·5449			
12 ...	1·7900	·3710	·5796	1·0500	3·7906	·5679	...	·0658	2·8668	3·5005	+ ·2901			
13 ...	1·6800	·3710	·5796	1·0500	3.6806	·6595	...	·0658	3·2567	3·9820	— ·3014			
14 ...	1·8100	·3710	·5796	1·0500	3·8106	·6383	...	·0658	2·9961	3·7002	+ ·1104			
15 ...	1·7300	·3710	·5796	1·0500	3·7306	·7251	...	·0658	2·9148	3·7057	+ ·0249			
16 ...	1·7600	·3710	·5796	1·0500	3·7606	·7676	...	·0658	3·0360	3·8694	— ·1088			
17 ...	1·6200	·3710	·5796	1·0500	3·6206	·8366	...	·0658	2·8560	3·7584	— ·1378			
18 ...	1·5500	·3710	·2691	1·0500	3·2401	·9029	·0800	·0658	2·8140	3·7627	— ·5226			
19 ...	1·6000	·3710	·4968	1·0500	3·5178	·6432	·0184	·0658	3·0600	3·7874	— ·2696			
20 ...	1·6200	·3710	·5796	1·0500	3·6206	·7339	·4498	·0658	2·7400	3·9895	— ·3689			
21 ...	1·8800	·3710	·5796	1·0500	3·8806	·8834	·2554	·0658	2·5400	3·7446	+ ·1360			
22 ...	1·7400	·3710	·5796	1·0500	3·7406	·8274	·3908	·0658	2·7080	3·9920	— ·2514			
23 ...	1·6500	·3710	·5796	1·0500	3·6506	·7342	·4744	·0658	2·9460	4·2204	— ·5698			
24 ...	1·5300	·3710	·5796	1·0500	3·5306	·7284	·2444	·0658	2·9800	4·0186	— ·4880			
25 ...	1·4800	·3710	·5796	1·0500	3·4806	·8505	·0929	·0658	2·8020	3·8112	— ·3306			
26 ...	1·5200	·3710	·5796	1·0500	3·5206	·7146	·0594	·0658	2·8380	3·6778	— ·1572		1,067·8	216·0
											+8·4877			
	45·5500	9·6390	16·8847	24·7737	96·9074	18·1102	2·0655	1·7108	70·0393	91·9258	—3·5061			
											+4·9816	149·448		

Health Period after treatment.

Total gain (during the 26 weeks) in body weight = 216 lbs.

Lbs.	
851·8	... 1st day of investigation.
1,067·8	... 182nd day of investigation.

Total gain ... 216·0 lbs.

Gain by Nitrogen ... 4·9816 lbs. Nitrogen.

30

149·4480 lbs. flesh at 1 : 30.

Gain by Nitrogen = 69·18 %
„ Fat, moisture, &c. = 30·82 %

Quantity of dry matter digested in the whole period.

		Lbs.		Lbs.	Lbs.
Total Hay	eaten	4,555 less water	10 % =	455·50	= 4,099·50
„ Lucerne	„	1,832 „	83·3 % =	1,526·05	= 305·95
„ Barley	„	1,144·69 „	12 % =	137·36	= 1,007·33
„ Bran	„	661·95 „	10·7 % =	70·82	= 591·13
				Total dry matter ingested	6,003·91

	Lbs.
Total dung passed =	8,557·75
Less 68 % water =	5,819·27
Dry dung	2,738·48

	Lbs.
Total dry matter eaten =	6,003·91
„ „ in dung =	2,738·48
	3,265·43

As 6,003·91 : 100 : : 3,265·43 : **54·38 %** dry matter digested in whole time.

TABLE V.

HORSE LXXXIX. *Showing the percentage of dry matter digested during 26 weeks convalescence from Surra.*

Number of weeks.	Total dry matter ingested.	:	100	: :	Total dry matter digested.	:	% Dry matter digested
	Lbs.				Lbs.		
1st week ...	210·54	:	100	: :	134·38	:	**63·82**
2nd „ ...	256·01	:	100	: :	164·97	:	**64·43**
3rd „ ...	259·23	:	100	: :	153·87	:	**59·35**
4th „ ...	260·67	:	100	: :	163·23	:	**62·61**
5th „ ...	269·67	:	100	: :	183·91	:	**68·19**
6th „ ...	260·60	:	100	: :	166·04	:	**63·71**
7th „ ...	235·03	:	100	: :	155·19	:	**66·02**
8th „ ...	214·12	:	100	: :	124·20	:	**58·00**
9th „ ...	213·26	:	100	: :	117·90	:	**55·28**
10th „ ...	245·57	:	100	: :	138·85	:	**56·54**
11th „ ...	244·66	:	100	: :	141·90	:	**57·99**
12th „ ...	234·76	:	100	: :	124·76	:	**53·14**
13th „ ...	224·86	:	100	: :	99·90	:	**44·42**
14th „ ...	236·56	:	100	: :	121·60	:	**51·40**
15th „ ...	229·70	:	100	: :	117·86	:	**51·31**
16th „ ...	232·06	:	100	: :	110·62	:	**47·66**
17th „ ...	219·46	:	100	: :	105·22	:	**47·94**
18th „ ...	199·76	:	100	: :	87·20	:	**43·65**
19th „ ...	214·09	:	100	: :	91·69	:	**42·82**
20th „ ...	219·46	:	100	: :	109·86	:	**50·05**
21st „ ...	242·86	:	100	: :	141·26	:	**58·16**
22nd „ ...	230·26	:	100	: :	121·94	:	**52·95**
23rd „ ...	222·16	:	100	: :	104·32	:	**46·95**
24th „ ...	211·36	:	100	: :	92·16	:	**43·60**
25th „ ...	206·86	:	100	: :	94·78	:	**45·81**
26th „ ...	210·46	:	100	: :	96·94	:	**46·06**
Whole period ...	6,003·91	:	100	: :	3,265·43	:	**54·38**

TABLE V (A).

HORSE No. LXXXIX. *Showing the percentages of ingested water excreted as urine, in the dung, and by the lungs and skin, during a period of 26 weeks convalescence from Surra.*

Weeks.	Urine %	In dung %	By lungs and skin % difference.	Weeks.	Urine %	In dung %	By lungs and skin % difference.
1	27·82	52·17	20·01	14	20·10	34·79	45·11
2	25·15	52·44	22·41	15	19·87	43·05	37·08
3	23·14	57·32	19·54	16	24·31	58·03	17·66
4	27·09	49·35	23·56	17	18·00	51·72	30·28
5	23·93	39·03	37·04	18	14·69	51·26	34·05
6	22·67	48·94	28·39	19	13·76	48·10	38·14
7	29·00	52·02	18·98	20	17·64	48·88	33·48
8	20·75	52·43	26·82	21	18·29	49·77	31·94
9	23·08	51·30	25·62	22	13·93	47·96	38·11
10	17·12	46·76	36·12	23	13·47	46·87	39·66
11	19·15	47·92	32·93	24	15·61	54·04	30·35
12	19·18	48·94	31·88	25	16·26	46·97	36·77
13	23·49	55·19	21·32	26	17·00	51·25	31·75

The means for the whole period of 26 weeks are:—

Urine, 20·17, in dung 49·48, and by lungs and skin 30·34.

The gradual falling off in the percentage of water excreted as urine, was probably due to the diminishing effect of the double iodides of Arsenic and Mercury, administered to the animal for 15 weeks previous to the above observations being made.

Horse No. XCI.

Australian gelding, aged 10 years, height 15·1, body weight 825 lbs.

This animal was subjected to experiment in Bombay, in order to test whether Rat *(Mus decumanus)* excrement, obtained from animals in whose blood the Trypanosoma was present at the time of collection, could communicate the disease when such excrement was administered daily in the corn.

After a period extending over five months the horse contracted the disease and was placed on a treatment of Arsenic. The following observations regarding the quantities of urine, urea, &c., were noted during the course of the disease:—

Urine.—During a period of 111 days, including four paroxysms of Surra occupying 18 days, and three intermissions lasting 93 days, the largest quantities of urine 4,189 c.c. and 4,180 c.c. were passed during the first and second paroxysms.

The average daily quantity voided during the paroxysms was 3,103 c.c., intermissions 1,698 c.c., and for the whole period 1,926 c.c.

Urea.—The mean maximum daily amount of urea, 153·69 grammes, was passed during the second paroxysm; the mean daily average for the paroxysms being 99·91 grammes, whilst that for the intermissions was only 41·36 grammes.

Arsenic.—This drug was administered 24 hours after the appearance of the organism in the blood, and was continued throughout the case, the animal showing reluctance to it. The total quantity during the case was 658·5 grains. A small quantity of the iodides of Arsenic and Mercury were given during the III intermission and IV paroxysm, and in addition Sulphate of Iron was administered during the latter half of the case.

Hippuric Acid.—There was no hippuric acid during the first paroxysm, but during the succeeding intermission, an average daily of 9·730 grammes was excreted. In paroxysm II this rose to 25·31 grammes, but again fell to 14·92 in the intermission. In the next paroxysm the mean daily was 15·79 grammes, but was only 1·05 in intermission III. In the sixth and last paroxysm it rose to 6·49 grammes daily. The mean for the paroxysms and intermissions was 15·02 and 12·87 grammes, respectively. The hippuric acid was excreted during 8 out of 11 days paroxysm, and in 81 out of 93 days intermission.

Albumen.—Traces of albumen were excreted during the intermission II, and paroxysm IV only, a total of 1·123 grammes.

No investigations were made during the health period on account of the animal being in Bombay, where the rat excrement was administered; and the horse was only received at the Poona Laboratory the day the disease made its appearance.

TABLE VI.

HORSE XCI. *Showing the mean daily averages and ratios, in health and treated Surra, of the Urine and its chief constituents, &c., together with the water drunk.*

Periods.		I. Paroxysm.	I. Intermission.	II Paroxysm.	II. Intermission.	III. Paroxysm.	III. Intermission.	IV. Paroxysm.	Paroxysm.	Intermission.	Whole Period.	Remarks.
Length Days.		6	26	4	63	2	4	6	18	93	111	
	Quantity.											
Urine	c.c.	4,189	2,282	4,180	1,440	1,775	1,969	1,742	3,103	1,698	1,926	
Ratio		1	·54	·99	·34	·42	·47	·41	·74	·40	·46	
Urea	Grammes.	99·89	48·86	153·69	35·46	51·47	84·82	80 25	99·91	41·36	50·83	
Ratio		1	0·48	1·53	0·35	0·51	0·84	0·80	1·00	0·41	0·50	
Hippuric Acid	Grammes.	...	9·73	25·31	14·92	15·79	1·05	6·49	15·02	12·87	*13·10	* days 104.
Albumen	Grammes.	...	...	...	1·104	...	...	0·019				
Water	Litres.	8·45	8·00	7·55	6·45	9·12	5·56	3·42	6·65	6·85	6·82	
Ratio		1	0·94	0·89	0 76	1·07	0·35	0·40	0·78	0·81	0·80	
Ratio Urea to Urine ..	1:	41·9	46·70	27·20	40·61	34·50	23·20	21·70	31·05	41·09	36·83	
Ratio Urine to Water ...	1:	2 02	3·50	1·81	4·47	5·14	2·82	1·96	2·14	4·03	3·54	
										Totals.		
Arsenic	Grains.	34·0	209·0	39·5	360·0	12·0	4·0	00·0	85·5	573·0	658·5	
Iodides As I_3	Grains.	...	...	...	...	...	4·74	6·0	6·0	4·74	10·74	
Hg I_2	"	...	...	...	...	...	4·74	6·0	6·0	4·74	10·74	
Iron Sulphate	Grains.	...	...	...	60	240	480	600	840	540	1,380	

Horse No. XCVI.

Country-bred chestnut, entire, aged, weight 648 lbs.

This experiment was undertaken with a view to reproducing Surra, somewhat after the natural mode, *viz.*, by gastric ingestion of soiled blood, and later to submit the animal to treatment by arsenic. Data were recorded daily of the output of urine and urea, together with the quantity of water drunk.

Urine.—The average daily amount of urine during the latent period was 2,619 c.c. or a little over the normal. In the paroxysms it was increased to 4,702 c.c., and in the intermissions it again fell to 2,933 c.c.

Urea.—During the latent period the average daily excretion amounted to 82·93 grammes, in the paroxysm lasting five days it rose to 192·39 grammes or over three times the normal, and on the last day of the paroxysm it reached 267·34 grammes or 9·4 ounces, equal to about 30 ounces of pure proteid.

Hippuric Acid.—It is of interest to note, that although the amount of this acid excreted daily, varied from *nil* to 26·2 grammes, yet the mean daily averages during the latent period, paroxysm and intermission were almost identical, *viz.*, 7·45, 7·29, 7·63 grammes, respectively. The respective periods lasting 7, 5 and 12 days.

Arsenic.—Treatment was commenced on the same evening of the day on which the Trypanosoma made its appearance in the blood, and was continued for 15·5 days, when death occurred. The total amount of arsenic was 178 grains or an average of 5·76 grains per dose.

Albumen.—No albumen appeared in the urine until the paroxyms, when a trace was present on one day. Minute quantities appeared also during the intermission, in all 0·698 grammes being passed.

TABLE VII.

HORSE XCVI. *Showing the mean daily averages and ratios, in latent period and treated Surra, of Urine and its constituents, &c., together with the water drunk.*

Periods.		Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Remarks.
Number of days.		7	5	12	24	
	Quantity.					
Urine	c.c.	2,691	4,702	2,933	3,231	
Ratio		1	1·74	1·09	1·20	
Urea	Grammes.	82·93	192·39	143·95	136·24	
Ratio		1	2·32	1·73	1·64	
Hippuric Acid	Grammes.	7·45	7·29	7·63	7·50	
Ratio		1	0·97	1·02	1·00	
Water	Litres.	19·36	25·54	18·31	19·29	
Ratio		1	1·32	0·95	0·99	
Ratio urea to urine ...	1:	32·40	24·40	20·40	23·71	
„ urine to water ...	1:	7·19	4·58	6·24	5·97	
Arsenic	Grains.	...	9·20	16·18	...	
*Albumen	Grammes.	...	9·214	0·484	...	* Total quantity entered.

C.—PRELIMINARY TREATMENT.

The following experiments were made to determine the efficacy of subjecting healthy animals to drugs, sufficient to cause the full physiological effects, previous to submitting them to experimental inoculation with Surra. The chemicals made use of during these experiments were—

(*a*) Arsenic, as Liq. Arsenicalis.

(*b*) Triodide of Arsenic and Binoxide of Mercury.

In these two cases—Horses Nos. XCVIII and XCIX—the quantity of urine, urea, hippuric acid and albumen, together with the water drunk, were noted daily.

The following are some of the results:—

Horse No. XCVIII.

Australian mare, aged. Height 15-3. Body weight 947 lbs.

Urine.—During a period of 21 days health, the daily average of urine voided was 3,163 c.c.; the daily average during the 54 days' administration of Arsenic (a daily dose 5·94 grains), was 2,851 c.c., showing a decrease, the effect of the Arsenic. At this stage subcutaneous inoculation with Surra was performed, and during the ensuing period of incubation, lasting five days, the average daily output was largely increased, *viz.*, 6,039 c.c. daily, and in the intermissions it fell to 3,976 c.c. daily

TABLE VIII.

HORSE XCVIII. *Showing the preliminary treatment, and the mean daily averages and ratios, in health and Surra, of the Urine and its chief constituents, together with the water drunk.*

Periods.		Health.	Preliminary Treatment.	Latent Period.	Paroxysm. I.	Intermission. I.	Paroxysm. II.	Intermission. II.	Paroxysm. III.	Intermission. III.	Paroxysm. IV.	Intermission. IV.	Paroxysm. V.	Intermission. V.	Paroxysm. VI.
Days.		21	54	5	5	6	6	5	2	2	4	3	4	3	6
Urine	c.c.	3,163	2,851	2,482	2,736	2,522	4,989	3,408	4,885	7,230	11,055	7,637	11,680	3,235	3,120
Ratio		1	0·90	0·78	0·86	0·79	1·57	0·97	1·54	2·28	3·49	2·41	3·66	1·02	0·98
Urea	Grammes.	31·95	73·09	62·37	93·09	61·78	75·36	77·79	76·86	96·56	120·61	126·56	129·69	95·45	68·20
Ratio		1	2·29	1·95	2·91	1·93	2·36	2·43	2·40	3·02	3·77	3·96	4·06	2·98	2·13
Hippuric Acid	Grammes.	12·23	3·94	0	0	0	0	0	0	0	0	0	0	0	0
Ratio		1	0·32	0	0	0	0	0	0	0	0	0	0	0	0
Albumen	Grammes.	...	...	...	...	...	...	...	0·157	0·404	0·374	0·427	0·545	2·765	1·263
Water	Litres.	21·05	10·34	12·54	4·61	8·49	6·55	6·95	7·41	12·82	14·66	17·86	16·24	1·49	...
Ratio		1	0·48	0·54	0·22	0·40	0·30	0·33	0·35	0·60	0·69	0·85	0·77	0·07	...
Ratio ... { Urea ... / Urine ... }		1 : 98·9	1 : 39·0	1 : 39·8	1 : 29·3	1 : 40·8	1 : 66·2	1 : 43·8	1 : 63·5	1 : 74·9	1 : 91·6	1 : 60·3	1 : 90·0	1 : 33·9	1 : 45·7
Ratio ... { Urine ... / Water ... }		1 : 6·64	1 : 3·63	1 : 5·05	1 : 1·68	1 : 3·37	1 : 1·31	1 : 2·04	1 : 1·52	1 : 1·77	1 : 1·33	1 : 2·34	1 : 1·39	1 : 0·47	1 : 0·0
Arsenic	Grains.	...	320·7	Nil.	22·55	...	...	...	...	...	.....	...	8·0	...	...
Double Iodides. As I_3 ...	,,	...	...	...	3·47	13·24	9·63	3·63	0	0	Adhatoda Vasicine 1·44 grams.	0	0	0	0
Double Iodides. Hg I_2 ...	,,	...	...	...	3·47	13·24	9·63	3·63	0	0	.....	0	0	0	0

Urea.—During the period of health the daily average excretion was 31·95 grammes; this was more than doubled (73·03) during the preliminary administration of Arsenic. After inoculation it fell to a daily average of 62·37 grammes, increased again during the six paroxysms to 91·92 grammes, and again fell during five intermissions to 87·33 grammes.

Hippuric Acid.—During the 21 days' health the daily average excretion of hippuric acid was 12·23 grammes. During the period of 54 days occupied by the preliminary treatment of Arsenic, the daily average for the first 21 days was 7·7 grammes, whilst that for the succeeding 15 days fell to 3·4 grammes, after which for the remainder of the case no hippuric acid was excreted.

Albumen.—No albumen appeared in the urine until the latter half of paroxysm III; after which it was present in the urine until the end of the case, the largest amount being passed during the last intermission and paroxysm. The total amount excreted during 22 out of 29 days was 35·4277 grammes, or a mean daily quantity of 1·610 grammes. Less albumen was passed during the paroxysms than in the intermissions, the ratio being as 1 : 2·16.

Arsenic in the form of Liq. Arsenicalis was administered during a period of 54 days before inoculation, 320·7 grains being given. During the latent period the drug was discontinued, but in paroxysms I and V, 22·50 and 8·0 grains were given respectively. In addition, during paroxysms I and II, and intermissions I and II, 29·97 grains of each of the Iodides of Arsenic and Mercury were administered.

Horse No. XCIX.

Australian bay gelding, aged. Body weight 911 lbs.

Urine.—During a period of eight days' health, the average daily output was 2,721 c.c. The effect of the double iodides administered for 46 days was to raise the average daily quantity to 3,336 c.c. After subcutaneous inoculation with Surra, the latent period, occupying four days, showed a further daily increase to 4,107 c.c. The paroxysmal average for 26 days was again very high, *viz.*, 8,510 c.c. and that during the intermissions lasting 36 days was only slightly less, *viz.* 8,430 c.c., this polyuria being probably due to the continued exhibition of the double iodides.

Urea.—In health the daily average excretion was 38·89 grammes; this amount was doubled by the administration of the iodides, and further increased during the period of incubation to 82·05 grammes. The latter quantity was almost doubled during the 24 days paroxysms, but fell to 124·95 grammes in the 36 days intermissions.

Hippuric Acid.—The average daily excretion during the period of health, lasting eight days, was 13·14 grammes, and during the preliminary treatment, when iodides were administered, the amount fell to 8·75 grammes. For the last 15 days of this treatment no hippuric acid was excreted, and from this time until the end of the case, 64 days later, no more was found.

Double iodides were administered during a period of 46 days before inoculation, 158 grains of each being given. During the latent period and two days of the first paroxysm, the drugs were discontinued, after which it was administered until the end of the case. In all, 347 grains each of the double iodides, and in addition 107·5 grains of arsenic, as Liquor Arsenicalis, were given during the 118 days the case lasted.

TABLE IX.

Showing the preliminary treatment and the mean daily averages and ratios, in health and Surra, of Urine and its chief constituents, &c., together with the water drunk.

Horse No. XCIX.

PRELIMINARY TREATMENT.

Double Iodides of Arsenic and Mercury.

Periods.		Health.	Preliminary Treatment.	Latent Period.	Paroxysm. I	Intermission. I	Paroxysm. II	Intermission. II	Paroxysm. III	Intermission. III	Paroxysm. IV	Intermission. IV	Paroxysm. V	Intermission. V	Paroxysm. VI	Intermission. VI	Paroxysm. VII	Intermission. VII
Days.		8	46	4	3	1	3	4	1	2	2	4	4	4	6	19	5	2
	Quantities.																	
Urine	c.c. ...	2,721	3,366	4,107	5,330	2,970	4,343	2,117	9,100	•5,655	8,887	5,259	6,531	9,822	9,831	11,000	12,648	5,700
Ratio		**1**	**1·23**	**1·50**	**1·96**	**1·09**	**1·59**	**0·77**	**3·34**	**2·07**	**3·26**	**1·93**	**2·40**	**3·60**	**3·61**	**4·04**	**4·64**	**2·09**
Urea	Grammes.	38·89	75·09	82·05	152·77	160·38	113·63	56·67	91·00	134·80	73·93	83·54	116·71	149·97	181·21	145·30	234·33	73·38
Ratio		**1**	**1·93**	**2·11**	**3·92**	**4·12**	**2·92**	**1·45**	**2·34**	**3·46**	**1·90**	**2·14**	**3·00**	**3·85**	**4·65**	**3·73**	**6·02**	**1·88**
Hippuric Acid	Grammes.	13·14	*8·75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Albumen	,, ...	...	†0·288	...	0·339	1·780	0·252	0·092	0·509	0·316	0·497	0·198	0·391	0·588	0·589	1·726	1·660	...
Water	Litres ...	30·78	15·70	14·53	7·79	14·25	11·39	6·05	9·69	7·41	9·67	10·12	9·96	11·52	12·63	9·56	5·62	0·28
Ratio		**1**	**0·51**	**0·47**	**0·25**	**0·46**	**0·37**	**0·19**	**0·31**	**0·24**	**0·32**	**0·32**	**0·32**	**0·37**	**0·41**	**0·31**	**0·18**	**0·009**
Ratio ... { Urea ... / Urine ... }		1 : 69·9	1 : 44·8	1 : 50·0	1 : 34·9	1 : 18·5	1 : 38·2	1 : 37·4	1 : 100·0	1 : 41·9	1 : 120·2	1 : 62·9	1 : 55·9	1 : 65·4	1 : 54·2	1 : 75·7	1 : 53·9	1 : 77·7
Ratio ... { Urine ... / Water ... }		1 : 11·31	1 : 4·66	1 : 3·54	1 : 1·46	1 : 4·79	1 : 2·62	1 : 4·04	1 : 1·06	1 : 1·31	1 : 1·08	1 : 1·92	1 : 1·53	1 : 1·17	1 : 1·28	1 : 0·86	1 : 0·44	1 : 0·04
Double Iodides. { As. I_3 ...	Grains ...	...	158·0	...	2·37	4·74	11·53	12·64	2·37	6·00	8·06	14·85	16·59	17·69	34·44	56·92	0·63	...
Double Iodides. { Hg. I_2 ...	,, ...	...	158·0	...	2·37	4·74	11·53	12·64	2·37	6·00	8·06	14·85	16·59	17·69	34·44	56·92	0·63	...
Arsenic	,, ...	...	...	...	...	...	15·5	1·6	...	...	...	...	...	...	...	77·9	12·5	...

* Hippuric acid mean daily average for 46 days, only excreted on 31 days.

† For one day only.

TABLE X.

Showing the chief facts connected with the undermentioned animals during different periods of health and disease (Surra) in the massed periods.

Periods.	Length of different Periods in days.						Body Temperature, Maximum and Minimum during each Period °C						Average daily Urine c.c.						Average daily Urea, Grammes.						Average daily Hippuric Acid, Grammes.					
	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Horse XCI	..	..	..	18	93	111	38·3 37·4	..	..	40·4 36·4	39·0 35·7	40·4 35·7	..	..	..	3,103	1,698	1,926	..	..	..	99·91	41·36	50·83	..	..	..	15·02	12·87	..
Horse XCII	..	..	6	28	6	50	38·2 37·2	..	41·1 37·1	42·0 36·4	39·8 36·3	42·0 36·3	1,489	..	1,271	1,632	1,962	1,599	17·68	..	23·25	61·68	79·89	50·45	7·88	..	12·22	1·36	0·36	..
Horse XCIII	..	..	9	20	15	44	38·0 37·2	..	41·2 36·6	41·7 36·2	41·0 35·5	41·7 35·5	2,490	..	2,989	7,452	5,429	5,227	46·64	..	44·24	99·82	68·98	72·14	3·48	..	3·48	2·79	..	..
Horse XCVI	..	..	7	5	12	24	38·8 36·5	..	38·2 36·6	40·6 37·2	38·2 35·2	40·6 35·2	..	..	2,691	4,702	2,933	3,231	..	..	82·93	192·39	143·95	136·24	..	..	7·19	4·58	6·24	..
Horse LXXXIX (1st series) Arsenic	..	6	..	6	5	60											1,543						28·71						16·14	
Horse LXXXIX (1st series) Iodides	..					106	37·0 35·4	..	37·6 35·1	40·3 36·6	40·0 35·3	40·3 35·3	1,255	..	1,364	1,892	3,162	4,437	21·42	..	19·71	52·90	86·53	80·33	11·08	..	18·62	12·49	2·18	..
Horse LXXXIX (1st series) No treatment.						226											6,026						94·91						4·14	
Horse XCVIII	..	21	54	5	27	24	131	38·4 37·4	38·4 36·6	39·4 37·8	41·2 37·8	40·2 37·6	41·2 36·6	3,163	2,851	2,482	6,039	3,976	3,750	31·98	73·09	62·37	91·92	87·33	72·63	12·33	3·94	..	..	..	..
Horse XCIX	..	..	8	46	4	24	36	118	37·8 37·3	39·2 37·2	38·4 37·7	41·7 37·4	40·2 36·8	41·7 36·8	2,721	3,366	4,107	8,510	8,430	5,938	38·89	75·09	82·05	156·82	124·95	102·07	13·14	8·75	..	..	..	..

Periods.	Total Albumen, Grammes.						Average daily Water drunk Litres.						Ratio of Urea to Urine 1 :						Ratio of Urine to Water 1 :						Total Treatment in Grains.						
	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	
Horse XCI	..	..	..	1·104	0·019	1·123	..	..	..	6·65	6·85	6·82	..	..	..	31·05	41·09	36·83	..	..	..	2·14	4·03	3·54	..	..	..	As. 85·5	As. 573·0	As. 658·5	
Horse XCII	..	..	0·086	..	0·070	4·554	0·170	4·880	..	..	..	..	..	..	84·26	..	54·66	26·45	24·55	31·70	..	..	..	..	..	..	..	AsI$_3$ 4·7 HgI$_2$ 4·7	6·0 6·0	10·74 10·74	
Horse XCIII	..	..	..	0·150	1 899	1·315	3·364	7·80	..	7·22	20·80	19·96	15·89	53·38	..	67·50	74·70	78·70	72·46	3·13	..	6·20	2·79	3·68	3·04	..	..	..	..	..	....	
Horse XCVI	..	..	..	..	0·214	0·484	0·698	..	..	19·86	21·54	18·31	19·29	..	..	32·40	24·40	20·40	23·71	..	..	7·19	4·58	6·24	5·97	..	..	..	9·20	16·18	25·38	
Horse LXXXIX (1st series) Arsenic	..	..	..	0·052	0·159	0·233	5·194	14·44	..	13·87	15·96	17·18	18·19	58·50	..	69·22	35·80	53·76	55·23	11·50	..	10·16	8·43	11·13	4·09	..	..	..	50	388	438·0	
Horse LXXXIX (1st series) Iodides	..					1·105					18·06						36·54						5·71		..	..	..	..	288	288	HgI_2
Horse LXXXIX (1st series) No treatment						3·645					18·78						63·49						3·12		..	..	..	..	288	288	AsI_3
Horse XCVIII	..	..	..	..	2·340	3·597	5·937	21·05	10·34	12·54	7·44	7·37	11·00	93·90	39·00	39·80	65·60	45·50	51·60	6·64	3·63	5·05	1·23	1·85	2·93	Arsenic. 320·7 HgI_2 .. AsI_3 ..	..		30·55 13·10 13·10	.. 16·87 16·87	351·25 29·97 29·97	
Horse XCIX	..	..	..	..	4·199	4·700	8·899	30·78	15·70	14·53	9·59	8·94	13·12	69·90	44·80	50·00	54·20	67·40	58	11·31	4·66	3·54	1·13	1·06	2·21	HgI_2 .. 158· AsI_3 .. 158· Arsenic. ..	.. ..		75·99 75·99 27·0	112·74 112·74 79·5	346·73 346·73 106·5	

SUMMARY OF RESULTS OBTAINED FROM INVESTIGATIONS WITH THE INGESTA AND EGESTA, DURING A PERIOD OF OBSERVATION, BEFORE AND SUCCEEDING INOCULATION WITH SURRA—

Animals untreated—Horse No. LXXXIX (2nd Series).
Mule No. I.
Do. No. II.

Horse No. LXXXIX.

The following are the condensed results, obtained from the investigation into the ingesta and egesta of Horse No. LXXXIX, an Australian gelding which had been subjected to Surra in 1893, and successfully treated with Arsenic and the Iodides of Arsenic and Mercury.

After a short period of observation, *viz.*, 14 days, this animal had a trace of soiled blood containing very numerous hæmatazoa inserted into a scratch on the muzzle, with a view to ascertain, whether one attack of Surra protects a horse against a second attack of the same disease. No immunity however was conferred.

Water drunk.—The average daily quantity of water drunk during the period of health was 27·24 litres; it increased four litres in the latent period, fell again during the first paroxysm and intermission, and again increased to 33·56 litres in the second paroxysm, the quantity then fell to a little below that of the health period. For the whole case the average daily quantity was 28·84 litres or 6·3 gallons.

Water in Food.—In addition to the above a mean daily average of 4·95 litres (10·89 lbs.) of water was taken in with the food, equal to a total of 33·79 litres or 7·4 gallons. The ratio of the water egested to ingested was in health 1 : 1·5, while in the intermissions it fell to 1: 1·76, the paroxysmal ratio being intermediate, 1 : 1·68.

The amount of water ingested daily during health was 1/16th of the body weight, whereas towards the end of paroxysm III it had fallen to 1/30th.

Food.—This consisted of hay, lucerne, gram and bran. The ration contained a daily average of 0·429 lbs. of Nitrogen.

The animal weighed at the commencement of the experiment 1,056·6 lbs. and at death, 73 days later, 771·6 lbs., shewing a loss in body-weight of 285 lbs., equal to 26·97%. The difference between the Nitrogen ingested in the food, and egested in the urine, dung, &c., during the same period amounted to 6·6873 lbs., equivalent, according to European investigations, to 200·619 lbs. of flesh. This loss by Nitrogen was 70·39 per cent. of the total loss of body-weight, leaving 29·61 per cent. due to carbonic acid, moisture, &c.

Urine.—The average quantity passed daily in England by horses in health, at rest and at work is 4,935 c.c. and 4,474 c.c. respectively (F. W. Smith). In this case in health the animal was passing 6,257 c.c., which was increased after inoculation to 8,284 c.c. and in the paroxysms it averaged 8,750 c.c., decreasing somewhat in the intermissions to 8,006 c.c. The average quantity passed daily throughout the whole case was 8,176 c.c., of which 34·10% was passed during the 12 hours, 6 P.M. to 6 A.M.

Urine was voided more frequently from 6 P.M. to 6 A.M., but less urine was passed during that part of the 24 hours.

Urea.—The average daily output in health was 115·89 grammes; it increased by 31·56 grammes daily during the latent period, and rose to a daily total of 206·42 grammes during the paroxysms; in the intermissions, which only lasted three and two days respectively, it averaged 190·38 grammes. The average output for the 73 days that the case lasted, was 182·26 grammes, a quantity nearly double the normal output of similar horses in England. Of this latter quantity 42·65 % was passed between 6 P.M. and 6 A.M., and 57·35 % during the remaining 12 hours.

The ratio of Urea to Urine.—The average of this in Europe for horses at rest is 1: 50·1 and at work 1: 45·4. In this case the animal was having walking exercise daily, and his average ratio in health was 1: 54·08, in latent period 1 : 56·18, in paroxysms 1: 42·39, and in intermissions 1: 42·05. While for the whole period it was 1 : 44·86.

Hippuric Acid.—In health this animal passed 25·02 grammes daily, being in excess of the amount stated for healthy animals in England, *viz.* 15·58 grammes (Smith). In the latent period it was 16·38 grammes, but during the first and second paroxysms it fell to 1·49 and 1·27 grammes daily respectively. During the first and second intermissions and third paroxysm no hippuric acid was excreted.

Albumen.—There was a slight trace of albumen during paroxysm I, the fifth day of the disease, but until the commencement of paroxysm III it was absent from the urine. Then it appeared in large quantities, as much as 116·112 grammes being passed in 24 hours during paroxysm III. The average daily amount of albumen during this period lasting 23 days was 38·253 grammes.

Total Solids in Urine.—The mean daily output during 73 days was 501·81 grammes. The largest quantity 615·91 grammes was passed during the latent period of the disease, whilst the smallest quantity, *viz.*, 448·22 grammes, was passed during the intermissions. This consisted chiefly of carbonate of lime in suspension in the urine, and urea, hippuric acid, albumen, &c., in solution.

Dung.—The average quantity passed daily throughout the whole case was 34·93 lbs., of which 51·74 % was passed between 6 P.M. and 6 A.M. Least dung was passed during the period 6 A.M. and noon, *viz.*, 17·57%, but in the 12 hours of day, 6. A.M. to 6 P.M., nearly half the total quantity was evacuated.

Table XI.

Horse Lxxxix. *Showing the mean daily averages, with percentages and ratios in health and Surra, of the Urine and its constituents, together with the water drunk, dung passed, and exercise taken.*

Periods. Days.	Quantity.	Health. 10			Latent Period. 7			Paroxysm I. 5			Intermission I. 3			Paroxysm II. 20			Intermission II. 2			Paroxysm III. 22		
Days.		Noon to 6 P.M.	6 P.M. to 6 A.M.	6 A.M. to noon.	Noon to 6 P.M.	6 P.M. to 6 A.M.	6 A.M. to noon.	Noon to 6 P.M.	6 P.M. to 6 A.M.	6 A.M. to noon.	Noon to 6 P.M.	6 P.M. to 6 A.M.	6 A.M. to noon.	Noon to 6 P.M.	6 P.M. to 6 A.M.	6 A.M. to noon.	Noon to 6 P.M.	6 P.M. to 6 A.M.	6 A.M. to noon.	Noon to 6 P.M.	6 P.M. to 6 A.M.	6 A.M. to noon.
Urine	c.c.	22·50	22·80	21·92	31·40	26·63	24·80	28·95	15·09	29·50	28·89	21·73	21·53	30·50	27·47	23·66	40·05	21·47	30·40	25·92	36·23	31·51
Percentages		33·46	33·92	32·61	37·90	32·15	29·94	39·36	20·51	40·10	40·04	30·11	29·84	37·36	33·64	28·95	43·57	23·36	33·07	27·67	38·67	33·66
Urea	Grammes.	35·68	49·50	33·82	50·10	63·07	33·19	61·40	47·61	61·40	62·10	71·19	40·78	62·51	67·83	55·07	88·13	61·73	65·35	46·43	115·21	64·88
Percentages		29·98	41·59	28·41	34·23	43·08	22·68	36·02	27·93	36·04	35·66	40·89	23·43	33·71	36·58	29·70	40·94	28·68	30·36	20·49	50·85	28·64
Hippuric Acid			21·46			15·75			1·49			...			6·68*			...			...	
Ratio			1·0			·73			·069			...			·31			...			...	
Albumen	Grammes.		...			...			...			...			...			...			38·21	
Water	Litres ...		27·24			31·99			26·64			25·55			33·56			31·20			25·64	
Ratio			1			1·17			0·97			0·93			1·23			1·14			0·94	
Ratio ... {Urea ... / Urine ...}	1:		54·08			56·18			42·47			41·57			43·10			42·63			41·84	
Ratio ... {Urine ... / Water ...}	1:		4·35			3·08			3·62			3·54			4·11			3·39			2·64	
Ratio of Water. {Egested to Ingested.}			1·50			1·57			1·54			1·74			1·91			1·79			1·57	
Ratio of Nitrogen. {Ingested to Egested.}			0·99			1·10			1·29			0·93			0·99			1·12			1·62	
Total Solids	Grammes. daily.	...	530·93			615·91			504·30			427·45			487·98			479·38			476·96	
Dung	Lbs.	10·92	25·07	8·12	15·07	24·17	9·03	14·00	22·50	4·75	12·25	14·83	5·83	11·06	16·01	5·89	8·37	19·00	7·00	7·94	14·36	5·23
Exercise	Miles.	...	6·28			5·85			4·05			5·25			5·26			5·25			†4·61	

* Mean for 4 days only. † For 13 days only.

Table XII.

Horse lxxxix. *Showing the Total Nitrogen ingested and egested in the different periods of health and Surra.*

Date.	Nitrogen ingested in food.					Nitrogen egested in urine, dung and sweat, &c.				Difference between ingested and egested Nitrogen.		Body weight of animal.
	Hay.	Lucerne.	Gram.	Bran.	Total.	Urine.	Dung.	Sweat.	Total.	+	−	
1895.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Health	2·8750	0·7434	3·5448	1·0500	8·2132	1·7020	6·3724	0·1316	8·2060	0·0072	...	1,056·6
Latent period	1·5300	0·3717	1·7724	0·5250	4·1991	1·1920	3·3780	0·0658	4·6358		0·4367	
Paroxysm I	0·8900	0·2655	1·2238	0·3620	2·7413	0·9650	2·5435	0·0470	3·5555		0·8142	
Intermission I	0·6600	0·1503	0·7174	0·2120	1·7487	0·5790	1·3825	0·0282	1·9897		0·2410	
Paroxysm II	3·5300	1·0600	5·0190	1·5009	11·1080	4·2330	6·5870	0·1880	11·0080	0·1000	...	
Intermission II	0·3300	0·1060	0·4220	0·1500	1·0080	0·4240	0·6870	0·0188	1·1298		0·1218	
Paroxysm III	3·0700	1·0760	1·7670	2·4000	8·3130	6·1800	2·5812	0·2068	13·4938		5·1808	771·6
										0·1072	6·7945	

Lbs.

Total loss in Body weight { 1,056·6 − 771·6 = 285·0

Loss by Nitrogen ... 6·6873 lbs.
30

Equivalent to 200·6190 lbs. flesh.

Loss by Nitrogen ... 70·39 %

„ CO_2 moisture, &c. ... 29·61 %

Temperature and Humidity of the Atmosphere.—This investigation was carried out during the hot season, February, March and April, in the Deccan. The maximum and minimum temperatures in the shade during the whole period of 73 days were 106·5° and 48°F., the mean maximum and minimum being 97·5° and 54·7°F. The mean humidity taken at 8 A.M. daily, during this period, was 44, with a maximum of 81, and minimum of 17.

Table XIII.

Horse lxxxix. *Showing the percentages of ingested Water excreted as urine, in the dung, and by the lungs and skin.*

Different periods of health and disease.	Urine %	In dung %	By lungs and skin % *difference.*	Total.	Days.
Health ...	18·57	43·29	38·14	100	14
Latent period ...	21·47	42·09	36·44	„	7
Paroxysm I ...	22·43	42·24	35·33	„	5
Intermission I ...	22·77	34·70	42·53	„	3
Paroxysm II ...	20·54	46·98	32·48	„	20
Intermission II ...	24·80	30·86	44·34	„	2
Paroxysm III ...	32·08	31·36	36·56	„	23

Table XIV.

Horse lxxxix. *Mean for the different periods massed together.*

Different periods.	In urine.	In dung.	By lungs and skin.	Total.	Days.
Health ...	18·57	43·29	38·14	100	14
Latent period ...	21·47	42·09	36·44	„	7
Paroxysms ...	25·49	40·06	34·45	„	48
Intermissions ...	23·66	33·01	43·33	„	5
Whole period ...	23·67	40·43	35·90	„	74

TABLE XV.

HORSE LXXXIX. *Percentage of dry matter digested during health and phases of Surra.*

	Total dry matter ingested.	:	100	::	Total dry matter digested.	:	Dry matter digested in different periods.
	Lbs.				Lbs.		%
Health ...	As 394·15	:	100	::	220·81	:	**56·02**
Latent period ...	„ 205·86	:	100	::	109·02	:	**52·95**
Paroxysm I ...	„ 127·13	:	100	::	68·03	:	**53·51**
Intermission I ...	„ 87·54	:	100	::	59·24	:	**67·67**
Paroxysm II ...	„ 512·44	:	100	::	323·56	:	**63·14**
Intermission II ...	„ 47·27	:	100	::	27·55	:	**58·28**
Paroxysm III ...	„ 433·20	:	100	::	251·78	:	**58·12**

Percentages of the Massed Periods

Health ...	As 394·15	:	100	::	220·81	:	**56·02**
Latent period ..	„ 205·86	:	100	::	109·02	:	**52·95**
Paroxysms ...	„ 1,072·78	:	100	::	643·37	:	**59·97**
Intermissions ...	„ 134·81	:	100	::	86·79	:	**64·38**
Whole period ...	„ 1,807·60	:	100	::	1,050·46	:	**58·11**

Quantity of dry matter digested in the whole period.

	Lbs.			Lbs.	Lbs.
Total Hay eaten ...	1,292·00	less water	10·0%	... 129·20 =	1,162·80
„ Lucerne eaten ...	713·00	„ „	83·3%	... 593·92 =	119·08
„ Gram „ ...	343·00	„ „	11·3%	... 38·75 =	304·25
„ Bran „ ...	248·00	„ „	10·7%	... 26·53 =	221·47
Total dry matter ingested ...					1,807·60

	Lbs.
Total dung passed	= 2,642·71
Less 71·35 % water	= 1,885·57
Total dry dung...	757·14
Total dry matter eaten	= 1,807·60
„ „ in dung	= 757·14
Dry matter digested...	1,050·46

As 1,807·60 : 100 :: 1,050·46 : **58·11** % dry matter digested in whole period.

TABLE XVI.

HORSE LXXXIX. *Showing the mean daily number of the different Blood Corpuscles in one cubic millimetre, with their ratios to one another, together with the percentage of Hæmoglobin during periods of health and disease (Surra).*

Periods.	No. of days.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles. 1 :	Ratio coarsely granular cells to white corpuscles. 1 :	Ratio coarsely granular cells to red corpuscles. 1 :	% Hæmoglobin.
Health	15	8,256,000	7,800	1,493	1,058	5·35	5,529	100·0
Latent period	7	9,058,571	7,114	1,085	1,273	6·55	8,348	105·5
Paroxysm I ...	5	8,334,000	9,480	240	879	39·50	14,725	100·3
Intermission I ...	3	6,906,000	10,400	1,266	664	8·21	5,455	82·3
Paroxysm II ...	20	6,684,000	10,200	1,030	655	9·72	6,489	76·0
Intermission II ...	2	5,475,000	11,600	1,200	472	9·66	4,562	62·5
Paroxysm III ...	22	6,285,454	13,736	572	457	2·40	10,988	71·9

TABLE XVII.

HORSE LXXXIX. *Showing the mean for health, latent period, paroxysms, intermissions and for the whole period.*

Periods.	No. of days.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles. 1:	Ratio coarsely granular cells to white corpuscles. 1:	Ratio coarsely granular cells to red corpuscles. 1:	% Hæmoglobin.
Health	15	8,256,000	7,800	1,493	1,058	5·35	5,529	100·
Latent period	7	9,058,571	7,114	1,085	1,273	6·55	8,348	105·5
Paroxysms	47	7,101,151	11,138	614	637	18·14	11,565	76·7
Intermissions	5	6,190,833	11,000	1,233	562	8·92	5,029	74·4
Whole period	74	7,196,486	10,470	954	687	10·97	7,543	83·4

TABLE XVIII.

HORSE LXXXIX. *Showing the percentage of Corpuscles in the massed periods, &c., taking the number in the health period as 100.*

Periods.	Red corpuscles %	White corpuscles %	Coarsely granular cells %
Health	100·00	100·00	100·00
Latent period	109·70	91·20	72·67
Paroxysms...	86·01	142·89	41·12
Intermissions	74·98	141·02	82·58
Whole period	87·16	134·23	63·89

Mule I.

Fawn-coloured gelding, aged, height 14-2½ hands, a strong animal in good health and condition. After a period of observation lasting 28 days, the animal was inoculated on the muzzle by means of a slight scratch, and a trace of blood containing numerous hæmatozoa, taken from a guinea pig primarily inoculated from Horse No. CVII, was smeared over the wound.

The period of incubation lasted 11 days; the disease ran its course in 75 days. The hæmatozoon was present in the blood for 49, and absent during the intermissions for 26 days.

The following are some of the chief results obtained:—

Water drunk.—During health 13·80 litres were taken daily; the amount rapidly decreased throughout the rest of the case, being in the latent period 12·23, paroxysms 9·68 and intermissions 7·37 litres, respectively. For the whole period, 114 days, it averaged 10·41 litres or 2·3 gallons.

Water in food.—In addition to the above, 4·38 litres (9·64 lbs.) were taken in daily as moisture in the fodder and grain, equal to a total of 14·8 litres or 3·25 lbs. ingested. The ratio of the water egested to ingested was in heath 1 : 1·71, it decreased in the latent period to 1 : 2·07, whilst during the paroxysms the ratio was the same as in health; but in the intermissions it rose to 1 : 1·54, and for the whole period of 114 days it was the same as in health.

The amount of water ingested during health was as 1 : 15·29 of the body-weight, whereas during the last paroxysms, of four days' duration, the ratio was 1 : 57·29.

Food.—This consisted of hay, lucerne, gram (for the first nine days), then barley and bran.

The animal weighed at the commencement of the experiment 698·5 lbs. and at death, 114 days later, 442·30 lbs., showing a loss in body-weight of 256·20 lbs., equal to 36·69 per cent.

The difference between the Nitrogen ingested in the food and egested in the urine, dung, &c., during the same period amounted to 56·82 per cent. of the total loss, calculated as proteid matter; the remaining loss was due to moisture, carbonic acid, &c.

Urine.—The mean daily quantity of urine voided in health was 2,514 c.c., it decreased slightly during the latent period, but nearly doubled during the paroxysms (4,642 c.c.). This latter quantity was slightly exceeded in the intermissions, the output being 4,683 c.c. For the whole period it averaged 3,914 c.c.

The maximum daily output during the paroxysms was 8,687 c.c. and the minimum 2,596 c.c.; in the intermissions it was 9,535 and 2,490 c.c. respectively.

Urea.—The daily excretion of urea in health was 91·24 grammes, with a maximum of 138·21 and a minimum of 54·45 grammes. It decreased in the latent period to 75·62 grammes, and the mean for the paroxysms was only 51·06 grammes, the maximum being 94·91 grammes, and the minimum 34·14 grammes. The mean for the intermissions showed a further decrease to 49·77 grammes, with a maximum of 81·61, and minimum of 39·92 grammes, respectively.

We have no statistics as to the normal output of urea in mules weighing about 700 lbs., but if the proportion to body weight is the same as for horses, the food and conditions being similar, a normal daily output would be about 68 grammes. Therefore in this case the excretion was unusually high for health.

Hippuric Acid.—The period of health extending over 28 days was marked by an entire absence of hippuric acid from the urine for the first three weeks, but a small quantity, 1·37 grammes, was excreted daily during the last seven days. After inoculation and during the latent period, the quantity varied daily, a large amount on one day being succeeded by an absence for two and three. When the temperature commenced to rise before the first appearance of the hæmatozoon, the excretion of hippuric acid greatly increased, 22·5, 30·0 and 23·5 grammes being respectively passed during the three days. When the fall in temperature took place, the excretion of hippuric acid ceased for 24 hours, and was only 2 and 3 grammes respectively for the following two days. The mean during the latent period was 10·15 grammes, this quantity fell to 5·68 grammes in the first paroxysm, and during the three following periods varied from 2 to 3 grammes only; but during paroxysm and intermission III, this amount was increased to 7·4 and 9·6 grammes, respectively. Just at this time the corn ration was refused by the animal, and a slight increased amount of hay was taken, which together with the rise in temperature on the last day of the paroxysm may have caused the increase. The disease passed through nine paroxysms and eight intermissions, but after a daily average of 1·03 grammes of hippuric acid during the fourth paroxysm, no more was excreted.

The following were the mean daily averages during the different periods:—Health 1·37, latent period 10·15, paroxysms 4·01, intermissions 6·23 grammes.

Albumen.—No albumen appeared in the urine until the last two days of the third paroxysm, when 3·08 grammes were found, and in the succeeding intermission 3·43 grammes. From this time until the end of the eighth paroxysm there was a daily average of 29·19 grammes. It then fell during the two following periods to 7·19 and 7·73 grammes, after which there was a complete absence until the second day of paroxysm XI, when a mean of 2·22 grammes was passed for two days.

Total Solids in Urine.—The mean daily output during 114 days was 193·83 grammes. The maximum mean daily quantity of the different periods, 273·70 grammes, was passed during the latent period of the disease, whilst the minimum mean daily quantity, 138·24 grammes, was passed during the intermissions. This consisted chiefly of carbonate of lime in suspension in the urine, and mucin, urea, hippuric acid, albumen, &c., in solution. During the course of the disease there was a gradual falling off in the amount of total solids in the urine, from 273·7 in the latent period to 67·16 in paroxysm XI. The ratio of the total solids in the different periods was—

Health	... 1.
Latent Period	... 1·03.
Paroxysms	... 0·62.
Intermissions	... 0·92.
Whole Period	... 0·73.

Dung.—The average quantity passed throughout the whole case of 114 days was 15·16 lbs.; the mean daily averages in the different periods were as follows:—

Health	... 30·36 lbs.
Latent Period	... 23·75 lbs.
Paroxysms	... 9 69 lbs.
Intermissions	... 5·56 lbs.

Temperature of the Air and Humidity.—This investigation was carried out during October 1894 to January 1895 inclusive. The maximum and minimum temperatures in the shade during the whole period were 92·5° F. and 50° F., the means being 86·1° and 58·1° F., respectively. The mean humidity taken at 8 A. M. daily during this period was 67, with a maximum of 97, and a minimum of 44.

TABLE XIX.

MULE I. *Showing the mean daily averages, with percentages and ratios in health and Surra, of the Urine and its constituents, together with the water drunk, dung passed, and exercise taken.*

Periods.		Health.	Latent Period.	Paroxysm I.	Intermission I.	Paroxysm II.	Intermission II.	Paroxysm III.	Intermission III.	Paroxysm IV.	Intermission IV.	Paroxysm V.	Intermission V.	Paroxysm VI.	Intermission VI.	Paroxysm VII.	Intermission VII.	Paroxysm VIII.	Intermission VIII.	Paroxysm IX.	Intermission IX.	Paroxysm X.	Intermission X.	Paroxysm XI.
Days.		28	11	5	1	7	1	4	2	3	2	3	4	6	1	4	2	6	5	4	4	3	4	4
	Quantity.																							
Urine	c. c. ...	2,514	2,420	2,842	2,610	5,263	3,120	2,596	2,490	4,415	6·945	8,687	4,212	4,862	5,660	7,215	9,535	5,082	5,349	3,720	2,552	4,117	4,659	2,742
Ratio		1·00	0·96	1·13	1·03	2·09	1·24	1·03	0·91	1·75	2·76	3·45	1·67	1·93	2·25	2·87	3·79	1·02	1·12	1·48	1·01	1·63	1·85	1·09
Urea	Grammes.	91·24	75·62	94·91	57·42	66·55	44·30	48·41	48·74	46·01	81·61	40·99	33·92	43·42	44·14	37·79	64·99	34·14	44·79	41·88	37·07	51·55	72·41	42·06
Ratio		1·00	0·82	1·04	0·62	0·72	0·48	0·53	0·53	0·50	0·89	0·43	0·37	0·47	0·48	0·41	0·71	0·37	0·48	0·45	0·40	0·56	0·79	0·56
Hippuric Acid	Grammes.	1·37	10·15	5·68	2·61	2·17	3·12	7·39	9·61	1·03	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ratio		1·00	8·40	4·14	1·90	1·58	2·27	5·39	7·01	0·75	...	...	...	...	...	..	...	...	...	...	...	...	...	...
Albumen...	Grammes.	...	...	...	...	...	...	1·54	1·71	10·13	38·93	27·41	31·39	36·63	42·65	24·12	29·84	28·40	7·19	7·73	0·00	0·00	0·00	2·22
Water drunk	Litres ...	13·80	12·23	11·06	11·40	11·89	8·55	12·97	13·11	13·30	11·97	15·01	7·55	10·83	7·41	10·12	7·69	7·88	8·77	4·84	2·71	4·36	3·42	3·49
Ratio		1·00	0·88	0·80	0·82	0·86	0·62	0·94	0·95	0·96	0·86	1·08	0·54	0·78	0·53	0·73	0·55	0·57	0·63	0·35	0·19	0·31	0·24	0·25
Ratio ... Urea ... / Urine ...	1 : ...	27·55	32·00	29·94	45·45	79·08	70·42	53·63	51·09	95·95	85·09	211·90	124·19	111·98	128·23	190·88	146·70	148·85	119·42	88·83	68·85	79·84	64·33	65·19
Ratio ... Urine ... / Water drunk.	1 : ...	5·49	5·05	3·89	4·36	2·26	2·74	4·99	5·26	3·01	1·72	1·72	1·79	2·22	1·31	1·40	0·80	1·22	1·64	1·30	1·06	1·06	0·73	1·27
Ratio water. Egested ... / Ingested ...	1 : ...	1·71	2·07	1·87	1·79	1·72	1·58	2·27	2·65	2·31	1·79	1·63	1·85	2·02	1·04	1·21	0·84	1·36	1·45	1·60	2·16	1·71	0·73	0·73
Exercise...	Miles ...	3	2·7	1·1	3	2	0	0·7	0	1·93	...	...	...	...	...	...	...	...	...	1	1·2	1	0·4	0
Dung	Lbs. ...	30·36	23·75	20·45	24·50	17·38	20·00	16·50	13·37	11·08	7·00	10·00	6·25	7·41	5·75	4·94	4·00	3·71	2·75	2·00	0·94	0·17	0·25	6·75

Table XX.

Mule I. *Showing the total amount of Nitrogen ingested and egested during health and the phases of Surra.*

Date 1895.	Nitrogen ingested in food.					Nitrogen egested in urine, dung and sweat.				Difference between ingested and egested Nitrogen.	Total difference.	Body weight of animal.
	Hay.	Lucerne.	Gram.	Bran.	Total.	Urine.	Dung.	Sweat.	Total.			
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Lbs.
Health	4·670	1·478	1·525	2·651	10·324	2·7780	7·2066	·1820	10·1666	+0·1574		679·9
Latent Period	1·620	0·583	0·500	0·820	3·523	1·0840	2·4557	·0715	3·6112	—0·0882		688·9
Paroxysm I	0·670	0·265	0·123	0·175	1·233	0·4609	0·8895	·0325	1·3829	0·1499		...
Intermission I	0·100	0·053	0·037	0·051	0·241	0·0681	0·2131	·0065	0·2877	0·0467		...
Paroxysm II	0·770	0·371	0·186	0·308	1·635	0·5392	1·3309	·0455	1·9156	0·2806		...
Intermission II	0·100	0·053	0·025	0·041	0·219	0·0549	0·2200	·0065	0·2814	0·0624		...
Paroxysm III	0·510	0·212	0·012	0·020	0·754	0·2770	0·6384	·0260	0·9414	0·1874		...
Intermission III	0·210	0·106	...	...	0·316	0·1493	0·2514	·0130	0·4137	0·0977		...
Paroxysm IV	0·410	0·159	·012	·020	0·601	0·1671	0·5652	·0195	0·7518	0·1508		...
Intermission IV	0·190	0·106	...	...	0·296	0·2060	0·2240	·0130	0·4430	0·1470		...
Paroxysm V	0·180	0·148	·025	·020	0·373	0·1528	0·4499	·0195	0·6122	0·2392		...
Intermission V	0·470	0·168	·037	·030	0·695	0·2431	0·7249	·0260	0·9940	0·2980		...
Paroxysm VI	0·450	0·238	·025	·040	0·753	0·3585	0·8010	·0390	1·1985	0·4455		...
Intermission VI	0·070	...	...	...	0·070	0·0651	0·1150	·0065	0·18 6	0·1166		...
Paroxysm VII	0·150	...	·025	·020	0·195	0·1837	0·4240	·0260	0·6337	0·3987		...
Intermission VII	0·090	0·016	·012	·020	0·138	0·1700	0·1396	·0130	0·3226	0·1846		...
Paroxysm VIII	0·205	0·026	·006	·010	0·247	0·2671	0·4456	·0390	0·7517	0·5047		...
Intermission VIII	0·200	...	...	...	0·200	0·2405	0·2014	·0325	0·4744	0·2744		...
Paroxysm IX	0·160	0·106	...	...	0·266	0·1792	0·1612	·0260	0·4350	0·1005		...
Intermission IX	0·060	0·185	...	...	0·245	0·1511	0·1000	·0260	0·2771	0·0221		...
Paroxysm X	0·125	0·106	...	...	0·231	0·1580	0·0150	·0195	0·1925	+0·0306		...
Intermission X	0·035	...	...	...	0·035	0·2950	0·0300	·0260	0·3510	—0·3160		...
Paroxysm XI	0·025	...	...	...	0·025	0·1743	0·3515	·0260	0·5518	—0·5268	—4·4508	442·3

Total loss in Body weight, 237·6 lbs.
Loss by Nitrogen 4·4508 × 30 = 133·524 lbs. flesh.
Nitrogen loss = 56·19 %
Moisture, CO_2, &c. = 43·81 %

Table XXI.

Mule I. *Showing the percentages of ingested water excreted as urine, in the dung, and by the lungs and skin.*

Periods.	Days.	Urine %	Dung %	By lungs and skin % *difference.*	Total.
Health	28	11·45	46·11	42·44	100
Latent Period	11	11·44	36·83	51·73	,,
Paroxysm I	5	16·06	37·47	46·47	,,
Intermission I	1	13·96	42·33	43·77	,,
Paroxysm II	7	28·47	29·56	41·97	,,
Intermission II	1	20·74	42·43	36·83	,,
Paroxysm III	4	14·32	29·33	56·35	,,
Intermission III	2	13·86	23·85	62·29	,,
Paroxysm IV	3	24·02	19·06	56·92	,,
Intermission IV	2	42·34	13·39	42·34	,,
Paroxysm V	3	37·12	16·21	46·67	,,
Intermission V	4	36·65	17·17	46·18	,,
Paroxysm VI	6	33·42	16·05	50·53	,,
Intermission VI	1	72·56	23·06	4·38	,,
Paroxysm VII	4	67·77	14·48	17·75	,,
Intermission VII	2	Egested	water exce	eded ingest	ed.
Paroxysm VIII	6	59·65	13·63	26·72	,,
Intermission VIII	5	59·28	9·51	31·21	,,
Paroxysm IX	4	53·22	8·95	37·83	,,
Intermission IX	4	41·40	4·76	43·84	,,
Paroxysm X	3	57·55	0·72	41·73	,,
Intermission X	4	Egested	water exce	eded ingest	ed.
Paroxysm XI	4		Ditto	ditto.	

Quantity of dry matter digested in the whole period:—

	Lbs.			Lbs.	Lbs.
Total Hay eaten	1,151·50	less water	10·0 % ...	115·15 =	1,03 :·35
„ Lucerne „	825·00	„ „	83·3 % ...	687·22 =	137·78
„ Gram „	27·00	„ „	11·3 % ...	3·05 =	23·95
„ Barley „	151·00	„ „	12·0 % ...	18·12 =	132·88
„ Bran „	102·25	„ „	10·7 % ...	10·94 =	91·31
			Total dry matter ingested	...	1,422·27

	Lbs.
Total dung passed =	1,753·00
Less 66·46 % water =	1,165·04
Dry dung ...	587·96

	Lbs.
Total dry matter eaten	1,422·27
„ „ in dung	587·96
Total dry matter digested	834·31

As 1,422·27 : 100 :: 834·31 : **58·66** % dry matter digested in whole period.

TABLE XXII.

MULE 1. *Showing the percentages of dry matter digested during health and the phases of Surra.*

Periods.	Length in days.	Total dry matter ingested. Lbs.	100	Total digested. Lbs.	% dry matter digested.
Health	28	As 610·45	: 100 : :	325·27	: 53·28
Latent period	11	„ 217·23	: 100 : :	129·60	: 59 66
Paroxysm I ...	5	„ 80·60	: 100 : :	46·30	: 57·44
Intermission I ...	1	„ 14·21	: 100 : :	5·99	: 42·15
Paroxysm II ...	7	„ 100·89	: 100 : :	60·30	: 59·76
Intermission II ...	1	„ 13·32	: 100 : :	6·61	: 49·62
Paroxysm III ...	4	„ 54·91	: 100 : :	32·60	: 59·36
Intermission III ...	2	„ 22·24	: 100 : :	13·26	: 59·62
Paroxysm IV ...	3	„ 43·24	: 100 : :	32·08	: 74·19
Intermission IV ...	2	„ 20·44	: 100 : :	15·74	: 77·00
Paroxysm V ...	3	„ 22·66	: 100 : :	12·59	: 55·56
Intermission V ...	4	„ 49·97	: 100 : :	41 58	: 83·21
Paroxysm VI ...	6	„ 51·13	: 100 : :	36·20	: 70·79
Intermission VI ...	1	„ 6·30	: 100 : :	4·37	: 69·36
Paroxysm VII ...	4	„ 18·88	: 100 : :	9·99	: 52·91
Intermission VII ...	2	„ 9·93	: 100 : :	6·24	: 9?·83
Paroxysm VIII ...	6	„ 19 95	: 100 : :	9·97	: 49·67
Imtermission VIII ...	5	„ 18·00	: 100 : :	12·80	: 71·11
Paroxysm IX ...	4	„ 17·74	: 100 : :	14·13	: 79·65
Intermission IX ...	4	„ 11·25	: 100 : :	9·57	: 85·06
Paroxysm X ...	3	„ 14·59	: 100 : :	14·33	: 93·21
Intermission X ...	4	„ 3·15	: 100 : :	2·64	: 83·81
Paroxysm XI ...	4	„ 2·25	: 100 : :	1·99	: 88·44

Percentages of different periods massed together.

Health	28	„ 610·45	: 100 : :	325·27	: 53·23
Latent Period... ...	11	„ 217·23	: 100 : :	129·60	: 59·66
Paroxysms	49	„ 426·84	: 100 : :	270·48	: 63·36
Intermissions	26	„ 168·81	: 100 : :	118·80	: 70·37
* Whole period ...	114	„ 1,422·27	: 100 : :	834·31	: 58·66

* 33·5 lbs. dung (added to the Whole Period) found in the intestines at the *post-mortem*.

TABLE XXIII.

MULE I. *Showing the mean daily number of the different Blood Corpuscles and Hæmatozoa in 1 cubic millimetre of blood together with their ratios one to another.*

Periods.	Days.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular cells to white corpuscles.	Ratio coarsely granular cells to red corpuscles.	Blood number of hæmatozoa in 1 c.mm.
Health	12	6,527,500	12,716	1,833	1 : 513	1 : 6·93	1 : 3,561	...
Latent period	11	6,560,909	11,436	1,582	1 : 599	1 : 7·23	1 : 4,336	...
Paroxysm I ..	5	6,276,000	9,760	320	1 : 643	1 : 3·05	1 : 19,612	552
Intermission I ...	1	6,100,000	12,600	400	1 : 484	1 : 31·50	1 : 15,250	...
Paroxysm II ...	7	5,447,143	8,400	628	1 : 648	1 : 13·37	1 : 8,673	1,082
Intermission II ...	1	4,560,000	14,200	200	1 : 321	1 : 71·00	1 : 22,800	...
Paroxysm III ...	4	3,997,500	9,450	450	1 : 423	1 : 21·00	1 : 8,883	1,051
Intermission III ...	2	3,385,000	14,000	100	1 : 242	1 : 140·00	1 : 33,850	...
Paroxysm IV ...	3	3,176,666	14,000	400	1 : 227	1 : 35·00	1 : 7,941	3,501
Intermission IV ...	2	3,015,000	10,400	100	1 : 289	1 : 104·00	1 : 30,150	...
Paroxysm V ...	3	3,000,000	12,400	200	1 : 242	1 : 62·00	1 : 15,050	5,907
Intermission V ...	4	3,015,000	17,000	550	1 : 177	1 : 30·91	1 : 5,482	...
Paroxysm VI ...	6	2,926,666	12,300	66	1 : 237	1 : 186·00	1 : 44,343	1,062
Intermission VI ...	1	2,860,000	17,000	400	1 : 166	1 : 43·00	1 : 7,150	...
Paroxysm VII ...	4	2,867,500	12,150	150	1 : 237	1 : 81·00	1 : 19,116	2,478
Intermission VII ...	2	2 845,000	10,500	200	1 : 271	1 : 52·50	1 : 14,225	...
Paroxysm VIII ...	6	3,395,000	16,666	366	1 : 203	1 : 45·53	1 : 9,276	3,303
Intermission VIII ...	5	3,026,000	22,960	360	1 : 132	1 : 63·77	1 : 8,405	...
Paroxysm IX ...	4	3,140,000	15,350	50	1 : 204	1 : 307·00	1 : 62,800	3,675
Intermission IX ...	4	3,229,500	21,000	0	1 : 153	...	...	...
Paroxysm X ...	3	3,556,666	15,600	0	1 : 223	...	...	3,213
Intermission X ...	4	4,200,000	16,700	0	1 : 251	...	...	...
Paroxysm XI ...	3	5,166,666	19,800	0	1 : 261	...	...	3·30

Massed Periods.

Health	12	6,527,500	12,716	1,833	1 : 513	1 : 6·93	1 : 3,561	...
Latent period	11	6,860,909	11,436	1,582	1 : 599	1 : 7·23	1 : 4,336	...
Paroxysms	48	4,003,958	12,04	271	1 : 312	1 : 47·24	1 : 14,774	2,347·93
Intermissions	26	3,417,692	17,207	223	1 : 198	1 : 77·16	1 : 15,326	...
Whole period	97	4,482,989	13,818	610	1 : 324	1 : 22·65	1 : 7,349	...

TABLE XXIV.

MULE I. *Showing the percentage of corpuscles in the massed periods, &c., taking the number in health as 100.*

Periods.	Red corpuscles %	White corpuscles %	Coarsely granular cells %
Health	100·00	100 00	100·00
Latent period	105·00	89·93	86·30
Paroxysms	61·34	100 69	14·78
Intermissions	52·35	135·31	12·16
Whole period	68·67	108·66	33·27

Mule II.

Fawn-coloured gelding, aged, height 14-3 hands, a strong animal, in good health and condition.

This mule was subcutaneously inoculated at intervals with the soiled blood of the Rat, (*M. decumanus*) on the following occasions, but with negative results—

(i) November 28th, 1894 ... 1·87 c.c. blood containing a few hæmatozoa.
(ii) December 2nd „ ... 1·25 c.c. „ „ very numerous „
(iii) „ 8th „ ... 0·60 c.c. „ „ numerous „
(iv) „ 15th „ ... 1·85 c.c. „ swarming with „
(v) „ 26th „ ... 0·91 c.c. „ containing numerous „

From this latter date until February 27th, 1895—63 days—no symptoms of Surra had manifested themselves, and the animal presented a bright and healthy appearance.

On February 28th, 1895, the animal was inoculated on the muzzle by means of a scratch, and a trace of soiled blood, containing numerous hæmatozoa, was lightly smeared over the surface of the wound. The blood was derived from a guinea pig, primarily inoculated from Horse No. CXXV.

The period of incubation lasted eight days, the disease ran its course in 53 days, but was not of a virulent type. The hæmatozoon was present in the blood for 39, and absent during the intermissions for 14, days.

Water drunk.—During health 11·73 litres were taken daily, the amount increased during the latent period to 13·78 litres. In the paroxysms it further increased to 18·97 litres, and in the intermissions fell to 15·5 litres. The average for the whole period (89 days) being about the same as the latter figure (15·68).

Water in food.—In addition to the above, 4·21 litres, or 9·27 lbs. were taken in daily as moisture in the fodder and grain, equal to a total 15·94 litres or 35·06 lbs. ingested. The ratio of the water egested to ingested was in health 1 : 1·73, it decreased in the latent period to 1 : 1·91, in the paroxysms to 1 : 2·02, and in the intermissions to 1 : 2·04, while for the whole period of 89 days it averaged 1 : 1·93.

The amount of water ingested during health was 1 : 19·78 of the body-weight, whereas during the last paroxysm the ratio was 1 : 9·07.

Food.—This consisted of hay and lucerne only. The animal weighed at the commencement of the experiment 705·6 lbs. and at death 575·0 lbs. The intestines contained as much as 84·75 lbs. of dung, and to this must be added 27·5 lbs. passed on the day of death, or a total of 112·25 lbs. dung equal to a little more than $\frac{1}{5}$ of the body-weight in health, or $\frac{1}{6}$ at death.

This fact made it a point of considerable difficulty to ascertain the true loss at different periods during the experiment.

The loss for the whole period was 130·6 lbs. or 18·50 % of the body-weight.

Urine.—The mean daily quantity of urine voided in health was 1,829 c.c., in the latent period it increased to 2,309 c.c. and nearly double (4,233 c.c.) during the paroxysms. In the intermissions there was again a fall to 3,869 c.c. and for the whole period of 89 days, the mean daily average was 3,246 c.c. The maximum average daily output during any of the paroxysms was 5,768 c.c. and the minimum 2,817 c.c., while in the intermissions it was 7,310 c.c. and 3,355 c.c. respectively.

Urea.—The average daily excretion of urea in health was 23·54 grammes, it increased in the latent period to 28·86 grammes, in the paroxysms it amounted to 52·02 grammes, and in the intermissions it further increased to 65·75 grammes, the maximum during any of the latter periods being 130·56, and the minimum 47·59 grammes. For the whole period the mean daily average was 43·14 grammes.

Hippuric Acid.—During the 28 days of health preceding inoculation the average daily excretion amounted to 27·05 grammes; in the latent period it was 27·94 grammes. In the first paroxysm it fell to 9·46 grammes, and during the first intermission, lasting one day only, there was an absence of hippuric acid. In the following paroxysms No. II, lasting eight days, traces of hippuric acid appeared on two days only, *viz.*, 3·9 and 3·2 grammes, respectively. For the remainder of the disease, which in all passed through seven paroxysms and six intermissions, no more hippuric acid was excreted.

Albumen.—During this case the urine was free from albumen.

Total Solids in the Urine.—The mean daily output during 89 days was 255·25 grammes. The maximum mean daily quantity 263·72 grammes was passed during the six intermissions, and the minimum was passed in the health period, *viz.*, 240·42 grammes. The largest quantity passed on any one day was 340·45 grammes in paroxysm VI, and the smallest quantity 138·37, passed during health. The ratio of the total solids in the different periods were—

Health	...	1·00
Latent period	...	1·07
Paroxysms	...	1·08
Intermissions	...	1·09
Whole period	...	1·06

Dung.—The average quantity passed daily throughout the whole case of 89 days was 21·69 lbs.; the mean daily averages in the different periods were as follows:—

Health	...	23·52 lbs.
Latent period	...	22·56 lbs.
Paroxysms	...	21·38 lbs.
Intermissions	...	18·32 lbs.

Temperature and Humidity of the Atmosphere.—This investigation was carried out during the hot season—February, March and April—in the Deccan. The maximum and minimum temperatures in the shade during the whole period of 89 days were 103·5° and 48° F., the mean maximum and minimum being 97·5° and 54·7° F. The mean humidity taken at 8 A.M. daily during this period was 44, with a maximum of 81, and minimum of 17.

TABLE XXV.

MULE II. *Showing the mean daily averages, with percentages and ratios in health and Surra, of the Urine and its constituents, together with the water drunk, dung passed, and exercise taken.*

Periods.		Health.	Latent Period.	Paroxysm I.	Intermission I.	Paroxysm II.	Intermission II.	Paroxysm III.	Intermission III.	Paroxysm IV.	Intermission IV.	Paroxysm V.	Intermission V.	Paroxysm VI.	Intermission VI.	Paroxysm VII.
Days.		28	8	4	1	8	3	3	6	2	1	4	1	15	2	3
	Quantity.															
Urine	c.c.	1,829	2,309	2,187	3,400	3,318	3,355	4,066	3,752	3,485	4,030	3,882	7,310	5,768	3,425	2,866
Ratio		1·00	1·26	1·19	1·85	1·81	1·83	2·22	2·05	1·90	2·20	2·12	3·99	3·15	1·87	1·56
Urea	Grammes...	23·54	28·86	53·59	130·56	56·25	72·65	43·75	47·59	24·48	58·83	56·46	65·05	54·59	81·37	46·51
Ratio		1·00	1·22	2·27	5·54	2·38	3·08	1·85	2·00	1·04	2·49	2·39	2·76	2·31	3·45	1·97
Hippuric Acid	Do. ...	27·05	27·94	9·46	0·00	*0·89	...	...	...	...	...	...	...	...	...	...
Ratio		1·	1·03	0·35	...	0·03	...	...	...	...	...	...	...	...	...	...
Albumen...	Do. ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Water	Litres ...	11·73	13·78	7·12	5·13	23·78	16·57	19·05	16·86	18·52	8·55	14·21	25·65	19·46	13·39	26 08
Ratio		1·00	1·17	0·60	0·43	2·02	1·41	1·62	1·43	1·58	0·72	1·21	2·18	1·65	1·14	2·22
Ratio ... {Urea / Urine} ...	1 :	77·69	80·00	40·81	26·04	58·98	46·17	92·95	78·83	142·36	68·50	68·76	112·37	105·66	42·09	61·62
Ratio ... {Urine / Water} ...	1 ;	6·41	5·97	3·25	1·51	7·16	4·94	4·68	4·44	5·31	2·12	3·66	3·51	3·37	3·91	9·09
Ratio Water {egested / ingested} ...	1 ;	1·73	1·91	1·39	1·50	1·99	2·10	2·05	2·16	2·07	1·24	1·92	2·10	2·03	2·11	2 68
Exercise	Miles ...	3	3·2	3·6	1·5	4·1	3·3	4·7	3·6	4·	4·	4·5	4·	4·5	4·	4·7
Dung	Lbs. ...	23·52	22·56	17·75	9·00	22·03	20·75	22·41	18·89	23·75	20·00	18·31	21·75	21·28	15·12	26·50

*For two days only.

Table XXVI.

Mule II. *Showing the total amount of Nitrogen ingested and egested during health, and the phases of Surra.*

Body weights at commencement of experiment and at death, respectively—705·6 and 575·0 lbs.

Periods.	Length of each period in days.	Nitrogen ingested as food.			Nitrogen egested in urine, dung and sweat.					Total.	Difference between ingested and egested Nitrogen	
		Hay.	Lucerne	Total.	Urea.	Ammonia	Hippuric Acid.	Sweat.	Dung.		+	−
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Health	28	3·875	1·484	5·359	0·6723	0·0386	0·1287	0·1820	4·6775	5·6991		0·3401
Latent Period ...	8	1·055	0·424	1·479	0·2354	0·0117	0·0380	0·0520	1·4981	1·8352		0·3562
Paroxysm I ...	4	0·420	0·185	0·605	0·2186	0·0109	0·0016	0·0260	0·5893	0·8464		0·2414
Intermission I ...	1	0·080	0·053	0·133	0·1331	0·0066	0·0000	0·0065	0·0864	0·2326		0·0996
Paroxysm II ...	8	0·930	0·421	1·354	0·4590	0·0229	0·0000	0·0520	1·0751	1·6090		0·2550
Intermission II ...	3	0·360	0·159	0.519	0·2223	0·0111	0·0000	0·0195	0·5789	0·8318		0·3128
Paroxysm III ...	3	0·350	0·159	0·509	0·1338	0·0066	0·0000	0·0195	0·5380	0·6979		0·1889
Intermission III ...	6	0·710	0·318	1·028	0·2912	0·0145	0·0000	0·0390	1·0192	1·3639		0·3359
Paroxysm IV ..	2	0·270	0·106	0.376	0·0499	0·0024	0·0000	0·0130	0·4085	0·4738		0·0978
Intermission IV ...	1	0·120	0·053	0·173	0·0600	0·0030	0·0000	0·0065	0·1640	0·2335		0·0605
Paroxysm V ...	4	0·600	0·212	0·812	0·2303	0·0115	0·0000	0·0260	0·5420	0·8098	·002	...
Intermission V ...	1	0·125	0·053	0·178	0·0663	0·0033	0·0000	0·0065	0·1522	0·2283		0·0530
Paroxysm VI ...	15	1·620	0·795	2·415	0·8352	0·0417	0·0000	0·0975	1·9155	2·8899		0·4749
Intermission VI ...	2	0·110	0·106	0·216	0·1660	0·0083	0·0000	0·0130	0·2117	0·3990		0·1830
Paroxysm VII ...	3	0·320	0·159	0·479	0·1423	0·0071	0·0000	0·0195	0·5565	0·7254		0·2464
Total ...	89	10·945	4·690	15·635	3·9157	0·2002	0·1683	0·5785	14·0129	18·8756	0·002	3·2425

	Lbs.
Total Nitrogen egested ...	18·8756
„ „ ingested ...	15·6350
Loss=	3·2405 = 97·2150 lbs. of flesh at 1 : 30.

	Lbs.
Total loss of body weight ...	130·6
„ by Nitrogen ...	77·43 per cent.
„ CO_2, water, &c. ...	25·57

Table XXVII.

Mule II. *Showing the percentages of ingested Water excreted as urine, in the dung, and by the lungs and skin.*

Period.	Days.	Urine %	Dung %	By lungs and skin % *difference.*	Total.
Health ...	28	10·49	46·31	43·20	100
Latent Period	8	12·04	40·26	48·70	„
Paroxysm I...	4	18·94	67·85	13·21	„
Intermission I...	1	34·93	31·40	33·67	„
Paroxysm II...	8	15·47	34·69	49·84	„
Intermission II...	3	15·40	32·20	52·40	„
Paroxysm III...	3	17·49	31·12	51·39	„
Intermission III...	6	17·32	28·89	53·79	„
Paroxysm IV .	2	14·57	33·60	51·83	„
Intermission IV...	1	30·33	50·35	19·32	„
Paroxysm V...	4	20·08	31·78	48·14	„
Intermission V .	1	18·37	18·03	63·60	„
Paroxysm VI...	15	22·11	27·00	60·89	„
Intermission VI...	2	19·01	28·14	52·85	„
Paroxysm VII...	3	9·08	28·14	62·78	„

TABLE XXVIII.

MULE II. *Percentage of Dry Matter digested during health and the phases of Surra.*

Periods.		Total dry matter ingested.	: 100 : :	Total dry matter digested.	% dry matter digested in different periods.
		Lbs.		Lbs.	
Health	As	395·51	: 100 : :	172·85	: 43·70
Latent period ...	„	108·31	: 100 : :	47·30	: 43·67
Paroxysm I ...	„	43·65	: 100 : :	19·65	: 45·01
Intermission I ...	„	8·87	: 100 : :	5·82	: 65·61
Paroxysm II ...	„	97·51	: 100 : :	37·93	: 38·89
Intermission II ...	„	37·41	: 100 : :	16·36	: 43·73
Paroxysm III ...	„	36·51	: 100 : :	13·77	: 37·71
Intermission III ...	„	73·92	: 100 : :	35·64	: 48·21
Paroxysm IV ...	„	27·64	: 100 : :	11·58	: 41·89
Intermission IV ...	„	12·47	: 100 : :	5·71	: 45·79
Paroxysm V ...	„	60·68	: 100 : :	35·92	: 59·19
Intermission V ...	„	11·92	: 100 : :	4·56	: 38·52
Paroxysm VI ...	„	170·85	: 100 : :	62·94	: 36·83
Intermission VI ...	„	13·24	: 100 : :	3·01	: 22·73
Paroxysm VII ...	„	33·81	: 100 : :	6·93	: 20·49
Percentages during massed periods, paroxysms, intermissions and whole period.					
Health	As	395·51	: 100 : :	172·85	: 43·70
Latent period ...	„	108·31	: 100 : :	47·30	: 43·67
Paroxysms ...	„	470·65	: 100 : :	188·75	: 40·10
Intermissions ...	„	157·83	: 100 : :	71·10	: 45·04
Whole period ...	„	1,133·50	: 100 : :	481·04	: 42·44

Quantity of dry matter digested in the whole period.

	Lbs.		Lbs.
Total hay eaten ...	1,095·00	Total lucerne eaten =	885·00
Less 10 % for water ...	109·50	Less 83·3 % for water =	737·20
Total dry hay ...	985·50	Total dry lucerne	147·80

	Lbs.		Lbs.
Total dry hay ...	985·5	Total dung ...	1,929·75
„ „ lucerne.	147·80	Less 66·2 % water ...	1,277·49
Total dry matter ingested ...	1,133·30	Dry dung ...	652·26

	Lbs.
Total dry matter ingested ...	1,133·30
„ in dung ...	652·26
	481·04

As 1,133·30 : 100 : : 481·04 : **42·44** per cent. Dry matter digested for whole period.

TABLE XXIX.

MULE II. *Showing the mean daily number of the different Blood Corpuscles and Hæmatozoa in one cubic millimetre, with their ratios one to another, and the percentage of Hæmoglobin during periods of health and disease (Surra).*

Periods.	Days.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular oxyphile cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular cells to white corpuscles.	Ratio coarsely granular cells to red corpuscles.	Number hæmatozoa in 1 c. mm. blood.	Per cent. hæmoglobin.
Health	28	6,480,000	10,964	2,621	1 : 591	1 : 4·18	1 : 2,472	...	100·0
Latent period	8	6,601,250	8,175	1,725	1 : 807	1 : 4·74	1 : 3,826	...	111·0
Paroxysm I ...	4	6,280,000	10,200	950	1 : 615	1 : 10·74	1 : 6,610	631	97·9
Intermission I ...	1	5,260,000	14,400	2,000	1 : 365	1 : 7·20	1 : 2,630	...	90·2
Paroxysm II ...	8	4,888,750	10,850	825	1 : 450	1 : 13·15	1 : 5,925	4,857	81·1
Intermission II ...	3	4,220,000	17,333	2,000	1 : 245	1 : 8·66	1 : 2,110	...	61·6
Paroxysm III ...	3	4,850,000	12,400	1,333	1 : 391	1 : 9·30	1 : 3,638	4,465	67·0
Intermission III ...	6	4,490,000	12,700	1,200	1 : 353	1 : 10·58	1 : 3,741	...	65·4
Paroxysm IV ...	2	4,345,000	14,700	1,300	1 : 295	1 : 11·31	1 : 3,342	107	72·8
Intermission IV ...	1	4,160,000	14,800	1,000	1 : 281	1 : 14·80	1 : 4,160	...	72·8
Paroxysm V ...	4	3,555,000	13,000	900	1 : 273	1 : 14·44	1 : 3,950	2,325	66·4
Intermission V ...	1	3,780,000	15,600	3,200	1 : 242	1 : 4·87	1 : 1,181	...	63·6
Paroxysm VI ...	15	3,453,333	12,253	906	1 : 281	1 : 13·52	1 : 3,811	1,502	53·7
Intermission VI ...	2	4,070,000	13,500	700	1 : 301	1 : 19·28	1 : 5,8 4	...	54·8
Paroxysm VII ...	3	3,756,666	19,266	1,066	1 : 195	4 : 18·07	1 : 3,524	3,257	52·3

TABLE XXX.

MULE II. *Showing the daily mean of Corpuscles in the massed paroxysms and intermissions.*

Periods.	Days.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular oxyphile cess in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular cells to white corpuscles.	Ratio coarsely granular cells to red corpuscles.	Number hæmatozoa in 1 c. mm. blood.	Per cent. hæmoglobin.
Health	28	6,480,000	10,964	2,621	1 : 591	1 : 4·18	1 : 2,472	...	100·00
Latent period	8	6,601,250	8,175	1,725	1 : 807	1 : 4·25	1 : 3,826	...	111·00
Paroxysms	39	4,223,333	12,251	1,036	1 : 345	1 : 11·82	1 : 4,076	2,476	67·12
Intermissions	14	4,352,857	14,285	1,485	1 : 304	1 : 9·62	1 : 2,931	...	65·32
Whole period	89	5,167,415	11,799	1,667	1 : 437	1 : 7·08	1 : 3,099	...	78·54

TABLE XXXI.

MULE II. *Showing the percentage of Corpuscles present in the massed periods, &c., taking the number in the health period as 100.*

Periods.	Red corpuscles %	White corpuscles %	Coarsely granular corpuscles %
Health	100·00	100·00	100·00
Latent period	101·87	74·56	65·81
Paroxysms	65·17	111·73	39·52
Intermissions	67·17	130·38	56·65
Whole period	79·74	107·61	63·60

Remarks comparing the results obtained in the cases of Mules I and II.

Two mules, No. I weighing 698·5 lbs. and No. II 705·6 lbs., appeared in perfect health and condition; No. II was fed on lucerne and hay, the other with corn in addition. During the period of (28 days) health, both animals walked 3 miles daily after inoculation; the mule receiving corn was only able to walk an average of 1·6 miles, during the first 62 days out of 114 under experiment, whilst Mule No. II, not receiving corn, was able to walk an average of 3·78 miles daily, until death from chloroform 89 days later.

In both instances, the quantity of urine excreted during the different periods of health and disease was somewhat similar, but there was a marked difference in the amount of urea. Mule I excreted in health an average of 91·24 grammes daily, which was four times the amount excreted by the other mule without corn. In the case of the former animal, the amount of urea in health was 91·24 grammes; this was reduced in the latent period by 17·1 %. It was further reduced in the paroxysms by 44·0 % and in the intermissions by 45·40 %, owing to the animal refusing his corn and part of his fodder at an early date of the disease during paroxysm I. Had the mule continued to eat his corn ration throughout, the amount of urea in the paroxysms would probably have exceeded that of health, as observed in previous cases. In the mule not receiving corn, the amount of urea in health was only 23·54 grammes, which increased 22 % in the latent period, and during the paroxysms and intermissions by 121 and 179 % respectively. The ratios for the different periods in each case, health being taken as 1, were :—

Animals	Health.	Latent Period.	Paroxysms.	Intermissions.
Mule I (corn) ...	1	0·88	0·56	0·54
Mule II (grass) ...	1	1·22	2·21	2·79

With regard to the hippuric acid, in Mule I, the excretion continued until the end of the fourth paroxysm, or 54·38 % of the total length of the case. The quantity was only small, but was highest during the latent period. From Table XIX it will be observed, that the excretion of hippuric acid ceased when exercise was discontinued, but it is doubtful whether this was the actual cause, as when exercise was recommenced at a later period no hippuric acid appeared in the urine.

In Mule II the amount of hippuric acid in health and the latent period was much higher than in Mule I, but it fell during paroxysm I, and disappeared in paroxysm II, although exercise was continued throughout the case. It is a point of interest that, as in

the former case, it was present for nearly an equal proportion of the whole period (55·05 %).

Further attention should be drawn to the ratio of urea and hippuric acid existing in these two cases—in Mule I the large amount of urea in health with the small quantity of hippuric acid, and in Mule II the small quantity of urea and large amount of hippuric acid.

The ratio of urea to hippuric acid during the period in which the latter was excreted, was, in Mule I, 20·9: 1, and in Mule II, 1·15 : 1, the difference being 14 to 1.

Albumen.—There is also a marked difference to be observed as regards the presence of albumen in the urine in the two mules. In No. I, which received corn in addition to the fodder, and which at an early stage of the disease was unable to take much exercise, a large amount of albumen appeared in the urine during the third paroxysm of Surra, in all 987·35 grammes being passed. In the case of Mule II receiving only fodder, and taking exercise daily until death, no albumen was found in the urine.

Water.—Although the animals were practically the same weight, and took nearly the same amount of water in health and the latent period, Mule II (on fodder only) took twice the quantity of water during the paroxysms and intermissions as Mule I (on corn); *vide* Table No. XXXII.

Another marked point of difference between these two animals was in the ratio of total water ingested to the body weight. In No. I, in health, it was about 1 : 15, and just before death as 1: 57. Whereas in No. II the ratios were 1 : 19·7 and 1: 9, respectively. The total loss of body weight in the two animals at the time of death was 36·69 % (corn): 18·5 % (fodder) or a ratio of 2 : 1.

Total Solids in Urine.—Mule I averaged less total solids daily than Mule II. The ratios for the different periods in each case, health period being taken as 1, were :—

Animals.	Health.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Mule I (corn)	1	1·03	0·62	0·52	0·73
Mule II (grass)	1	1·07	1·08	1·09	1·06

It will be observed in the above table that, as in other particulars noted, the ratios are almost diametrically opposite.

Dung.—Mule I passed more in health than the one on fodder only, but the amount passed by the former decreased more rapidly, as the disease advanced, the ratios being respectively—

Animals.	Health.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Mule I (corn)	1	0·74	0·32	0·11	0·50
Mule II (grass)	1	0·99	0·90	0·77	0·92

Temperature and Humidity of the Atmosphere.—It was necessary to take these factors into account, when dealing with experiments on the ingesta and egesta of fluids, owing to the great variation of temperature and humidity daily, this being more important in the tropics than in temperate climates. Although these experiments were carried out during the driest period of the year, the temperature and humidity varied as follows :—

		Temperature° Fahrenheit Mean.				Humidity.		
Animals.	Length of case.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Mean.
	Days.							
Mule I (corn) ...	114	92·5	50·0	86·1	58·1	97	44	67
Mule II (grass) ...	89	106·5	48·0	97·5	54·7	81	17	44

Table XXXII.

Showing the chief facts connected with the undermentioned animals, during the different periods of health and disease (Surra) massed together.

Periods.	I. Body weights at different periods of Health and Disease.					II. Length of different Periods in Days.					III. Body Temperature, maximum and minimum, during each Period. ° C.					IV. Average daily Urine, c.c.					V. Average daily Urea, Grammes.					VI. Mean daily Amount of dung passed in different periods.				
	Health.	Latent Period.	Weight at death.	Total loss.	Mean daily Loss in Paroxysms and Intermissions.	Health.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Health.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.

SUMMARY OF OBSERVATIONS MADE WITH REGARD TO THE CHANGES OCCURRING IN THE CONSTITUENTS OF THE URINE, AND THE INGESTA AND EGESTA, BEFORE AND AFTER SEVERAL UNSUCCESSFUL INOCULATIONS WITH THE HÆMATOZOON OF THE BANDICOOT, AND BEFORE AND AFTER THE ADMINISTRATION OF THE DOUBLE IODIDES OF ARSENIC AND MERCURY.

Donkey No. IV.

This animal, a country bred, aged 10 years, height 9 hands, 2 inches, was in good health and condition.

Subcutaneous inoculation was performed at intervals as under—with blood derived from different Bandicoots, with a view to produce Surra, but always with negative results.

(i) 12th Sept. 1894.—Inoculated subcut. 0·6 c.c. blood containing very numerous hæmatozoa.

(ii) 9th Dec. 1894.—	„	„	3·25cc.	„	„	swarms of hæmatozoa.
(iii) 15th Jan. 1895.—	„	„	2·4	„	„	swarming „
(iv) 17th Jan. 1895.—	„	„	2·6	„	„	teeming „
(v) 22nd Jan. 1895	(on muzzle)	trace		„	„	very numerous hæmatozoa.
(vi) 3rd April 1895.—	„	„	2·0	„	„	„ „
(vii) 8th April 1895.—	„	„	7·5	„	„	numerous „

Between the 5th and 6th inoculations after a period of observation, the animal was submitted to a course of the Iodides of Arsenic and Mercury, with two objects in view—(i) To observe the changes which occurred in the constituents of the urine, during and after the administration of the drug, as also with regard to the corpuscular elements of the blood. (ii) To render the animal, if possible, more susceptible to the organism of the Bandicoot at the succeeding inoculation.

The following are the points of interest noted:—

Water drunk.—The quantity varied considerably throughout the case, from 1·90 to 7·82 litres daily. On reference to Table XXXIII, it will be seen that the gradual rise during the last 92 days the animal was under observation, took place during the months of January to April inclusive, the progressively hot months in the Deccan. For the whole period of 228 days the quantity averaged 4·01 litres daily.

Water in food.—In addition to the above, must be added a mean daily average of 5·49 lbs. of water in the fodder and grain, equal to a total of 6·5 litres or 14·31 lbs. The ratio of the total water egested to ingested, averaged during the whole period of 228 days, 1 : 2·13.

The average amount of water ingested daily was about $\frac{1}{13}$th of the body weight at the commencement, and $\frac{1}{12}$th at the end of the case.

Food.—The food consisted of hay, lucerne, barley and bran, but the two latter were discontinued after the 87th day under observation, the fodder alone being given. The animal weighed at the commencement of the investigation 192·20 lbs. and at the end, 228 days later, 179·9 lbs. This shows a difference of about 12 lbs., but the weight a week previously shows the variability due to the accumulation of fæces in the intestines, and urine in the bladder.

Urine.—The mean daily urine, which was 1,540 c.c. for the first six days after the first inoculation, fell during the succeeding 80 days' observation to a mean of 814 c.c.; it rose again immediately after the 2nd, 4th and 5th inoculations. During the administration of the iodides, the daily quantity was lowered, but as in the case of Horse No. LXXXIX (1st series), it greatly increased after the iodides were discontinued, and this increase was maintained for a long period.

Urea.—The effect of the different inoculations was to lower the excretion of urea from 23·78 to 10·02 grammes daily, or 2·37 to 1. As with the urine, the Iodides of Arsenic and Mercury caused a gradual rise during the administration of the drugs, and a continuous and marked rise for the next 58 days the animal was under observation. This ratio was as 1 : 1·85.

Hippuric Acid.—A few days after the first inoculation, hippuric acid appeared in the urine for the first time; immediately after the other inoculations the amount decreased, but rose again during the period of rest before the succeeding inoculation. During the period of observation previous to administering the iodides, the mean daily quantity was 12·62 grammes, which diminished while the iodides were being taken, to 8·27 grammes, and further to 2·39 grammes after they were discontinued. After the sixth and seventh inoculations, the mean average excretion was only 0·24 and 0·97 grammes respectively.

Albumen.—Traces were passed occasionally on 22 days out of the 228, chiefly after the first and second inoculations. The total amount excreted was only 1·17 grammes.

Total Solids in the Urine.—The total solids were decreased during the administration of iodides, but gradually rose during the 36 days succeeding, from 86·32 to 118·41 grammes, but again decreased after the seventh inoculation.

Dung.—The mean daily average of dung varied from 5·79 to 7·50 lbs. during the first eight periods. During the administration of iodides it fell from 7·30 to 5·51 lbs. daily, but in the next succeeding periods rose to 6·21 and 7·75, respectively, and after the seventh inoculation attained 7·95 lbs.

TABLE XXXIII.

DONKEY IV. *Showing the mean daily quantities, with their ratios, of Urine, Urea, Hippuric Acid, Albumen, Total Solids and Dung passed before and after several inoculations with the Hæmatozoon of the Bandicoot, also before and after the administration of the double Iodides of Arsenic and Mercury.*

Periods.		Succeeding 1st inoculation.	Succeeding 1st inoculation.	Observation.	Succeeding 2nd inoculation.	Succeeding 2nd inoculation.	Succeeding 3rd inoculation.	Succeeding 4th inoculation.	Succeeding 5th inoculation.	Observation.	Administration of Iodides.	After Iodides.	Succeeding 6th inoculation.	Succeeding 7th inoculation.	Remarks.
Days.		6	23	57	8	29	3	5	5	10	24	31	5	22	
Quantities.															
Urine	c.c.	1,540	990	743	794	887	605	1,040	1,021	938	826	1,120	1,013	1,188	
Urea	Grammes	23·78	19·30	19·59	22·39	16·95	12·49	10·65	13·37	10·02	11·22	14·43	16·42	18·61	
Hippuric Acid	Grammes	...	0·180	4·077	3·509	2·374	4·776	2·067	2·778	12·625	8·274	2·398	0·241	*0·970	*1 day only
Albumen	Grammes	...	0·4290 2 days.	0·0833 9 days.	0·0476 2 days.	0·6107 9 days.	...	...	...	...	...	...	...	...	22 out of 228 days.
Water drunk	Litres	2·56	2·97	2·79	4·27	3·97	1·90	4·16	3·30	2·99	3·79	4·87	7·29	7·82	
Total solids	Grammes	...	...	...	...	...	...	...	...	†94·74	86·32	97·69	118·41	96·16	†3 days only.
Dung	Lbs.	5·79	6·70	6·65	6·03	7·33	7·16	6·60	7·50	7·30	5·51	6·21	7·75	7·95	
Exercise	Miles	...	...	2·42	2·10	2·16	2·00	2·40	2·40	2·60	1·54	3·10	3·00	3·36	
Ratio total water $\left\{\frac{\text{egested}}{\text{ingested}}\right\}$	1:	1·53	1 93	1·93	2·89	1·96	1·60	1·91	1·81	1·71	2·27	2·31	2·19	2·76	
Ratio $\left\{\frac{\text{Urea}}{\text{Urine}}\right\}$	1:	69·62	49·72	40·68	36·39	51·73	48·42	12·02	76·36	92·56	73·69	83·21	61·66	63·82	
Ratio $\left\{\frac{\text{Urine}}{\text{Water}}\right\}$	1:	1·66	3·10	3·50	5·24	4·52	3·14	4·00	3·23	3·76	4·59	4·06	7·20	6·58	
Iodides of As. & Hg.	Grains	...	...	...	...	...	...	...	...	...	142·99 of As. I_3 142·99 of Hg. I_2	...	...	...	

Table XXXIV.

Donkey iv. *Showing the total amount of Nitrogen ingested and egested during periods of observation, after unsuccessful inoculations with the Hæmatozoon of the Bandicoot, and during and after the administration of the double Iodides of Arsenic and Mercury.*

Periods.	Days.	Nitrogen ingested.	Nitrogen egested.	Nitrogen, difference.	Equivalent to pounds of flesh.	
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Succeeding 1st inoculation ...	6	0·5275	0·5635	—·0360	—1·080	192
Observation	80	9·9860	8·4130	+1·5730*	+47·190	
Succeeding 2nd inoculation ...	8	0·8120	0·8000	+0·0120	+00·360	
Observation	29	2·6085	3·2033	—0·5948	—17·844	
Succeeding {3rd, 4th, 5th} inoculations ...	13	0·8650	0·9893	—0·1243	—3·729	
Before Iodides	10	1·1545	1·3901	—0·2356	—7·068	
During administration of Iodides.	24	2·3310	1·9988	+0·3322	+9·966	
After administration of Iodides...	31	2·8275	2·9203	—0·0928	—2·784	
Succeeding 6th inoculation ...	5	0·4375	0·5711	—0·1336	—4·008	
Succeeding 7th inoculation ...	22	1·9830	2·6363	—0·6533	—19·599	180
Total ...	228	23·5325	23·4857	+0·0468	+1·404	12

Total loss in body weight = 12 lbs.

Gained by Nitrogen = 0·0468 lbs. = 1·40 lbs. flesh.

∴ Loss in body weight due to dung and fæces; at the same time the animal has probably lost in fat and moisture, and gained slightly in flesh.

Table XXXIV(A).

Donkey iv. *Showing the percentage of ingested water excreted as urine, in the dung, and by the lungs and skin.*

Period.	Days.	Urine. %	Dung. %	By lungs and skin %.	Total.
Succeeding 1st inoculation	6	29·43	35·73	34·84	100
Observation	80	14·59	36·66	48·75	...
Succeeding 2nd inoculation	8	11·95	28·70	59·35	...
Observation	29	14·25	40·13	45·62	...
Succeeding {3rd, 4th, 5th} inoculations ...	13	17·01	39·97	43·02	...
Before Iodides	10	16·06	39·76	44·18	...
During administrations of Iodides ...	24	12·82	28·91	58·27	...
After do. do. ...	31	15·07	28·60	56·33	...
Succeeding 6th inoculation	5	9·94	25·37	64·69	...
Succeeding 7th inoculation	22	11·35	24·63	64·02	...
Whole period ...	228	14·23	33·01	52·76	...

TABLE XXXV.

DONKEY IV. *Showing percentage of dry matter digested during periods of observation after unsuccessful inoculation with the Hæmatozoon of the Bandicoot, and during and after the administration of the double Iodides of Arsenic and Mercury.*

Periods.	Days.	Total dry matter ingested.	:	100	::	Total dry matter digested.	:	% Dry matter digested.
		Lbs.				Lbs.		
Succeeding 1st inoculation ...	6	31·62	:	100	: :	22·34	:	64·52
Observation	80	615·09	:	100	: :	426·97	:	69·31
Succeeding 2nd inoculation ...	8	58·41	:	100	: :	41·36	:	70·81
Observation	29	191·62	:	100	: :	116·45	:	60·77
Succeeding {3rd, 4th, 5th} inoculations...	13	81·96	:	100	: :	49·95	:	60·33
Before Iodides	10	65·50	:	100	: :	39·70	:	60·61
During administration of Iodides.	24	174·84	:	100	: :	128·11	:	73·27
After administration of Iodides.	31	203·73	:	100	: :	135·63	:	66·57
Succeeding 6th inoculation ...	5	31·70	:	100	: :	18·00	:	56·78
Succeeding 7th inoculation ...	22	145·72	:	100	: :	83·89	:	57·56

Quantity of dry matter digested in the whole period—

	Lbs.		Lbs.	Lbs.
Total hay eaten	1,416·1	less 10 % water...	141·61	=1,274·49.
„ Lucerne „	1,140·0	„ 83·3% „ ...	949·62	= 190·38.
„ Bran „	79·0	„ 10·7% „ ...	8·45	= 70·55.
„ Barley „	78·0	„ 12·0% „ ...	9·36	= 68·64.

Total dry matter ingested ... 1,604·06

		Lbs.
Total dung passed	=	1,534·50
Less 64·67 per cent. water	=	992·36
		542·14
Total dry matter eaten	=	1,604·06
„ „ in dung	=	542·14
Dry matter digested	=	1,061·92

1,604·06 : 100 : : 1,061·92 : 66·20% dry matter digested in whole period.

The following observations were made with regard to the changes in the blood, before and after several inoculations, and administration of Iodides of Arsenic and Mercury.

The blood was microscopically examined for several days previous to inoculation, and then for the 30 succeeding days, during which no hæmatozoa appeared.

Periods.	Days.	Blood of animal.	Quantity inoculated c. c.	No. of Hæ.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular corpuscles in 1 c. mm.	Ratio of W. C. to R. C.	Ratio of C. G. C. to W. C.	Ratio of C. G. C. to red corpuscles.
Observation	7	* Bandicoot.	0·6 Subcut.	V. N.	5,330,000	15,400	Not examined for	1 :347	...	...
Succeeding 1st inoculation ...	7				5,540,000	41,429		1 :133	...	...
Ditto ditto ...	23				5,363,043	21,609		1 :248	...	...

* [Mus (Nesokia) giganteus.]

The blood was then examined for a period of 57 days, in order to allow for the disease to develop if the animal was susceptible. During this time the coarsely granular corpuscles were numbered in addition. The animal was then re-inoculated with Bandicoot's blood, and the examination continued for a further period of 37 days.

Periods.	Days.	Blood of animal.	Quantity inoculated, c.c.	No. of Hæ.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular corpuscles in 1 c. mm.	Ratio of W. C. to R. C.	Ratio of C. G. C. to W. C.	Ratio of C. G. C. to red corpuscles.
Observation	57	Bandicoot.	3·25 subcut.	Swarming	5,249,298	15,997	2,095	1 :328	1: 7·6	1: 2·505
Succeeding 2nd inoculation ...	8				5,001,250	17,312	2,750	1 :288	1: 6·3	1 :1·818
Ditto ditto ...	29				4,874,827	14,000	1,786	1 :348	1: 7·8	1 :2·729

The animal was now again inoculated subcutaneously, three times in succession, with an interval of two days between the first and second, and five between the second and third inoculations. After the latter, the examination was continued for a further period of five days, during which the blood remained free from organisms.

Periods.	Days.	Blood of animal.	Quantity inoculated c.c.	No. of Hæ.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular 1 c. mm.	Ratio of W. C. to R. C.	Ratio C. G. C. to W. C.	Ratio C. G. C. to red corpuscles.
Succeeding 3rd inoculation ...	3	Bandicoot.	2·4	Swarming	4,996,000	23,600	1,400	1 :211	1: 16·8	1 : 3,568
Ditto 4th ditto ...	5		2·6	Teeming	4,990,000	18,800	480	1 :265	1: 39·1	1 :10,395
Ditto 5th ditto ...	5		trace.	V. N.	5,100,000	20,400	1,120	1 :250	1: 18·2	1 : 4,553

After a period of ten days during which the observations were continued, it was decided to administer gradually increasing doses of the Iodides of Arsenic and Mercury, with a view to determine the changes, if any, which such drugs produce, and further, whether the animal, which up to the present had been refractory to the hæmatozoon, would become more susceptible, as the drug had been previously observed in one case to produce such effect. After waiting a period, the animal was again inoculated subcutaneously, with 2 c.c. of Bandicoot's blood containing very numerous hæmatozoa. As no local symptoms supervened, five days later a further 7.5 c.c. of blood containing numerous hæmatozoa were injected.

Periods.	Days.	Blood of animal.	Quantity inoculated c. c	No. of Hæ.	Double Iodides of Mercury and Arsenic.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular in 1 c. mm.	Ratio W. C. to R. C.	Ratio C. G. C. to W. C.	Ratio C. G. C. to red corpuscles.
					Grains.						
Observation	10	...	..	...	...	5,136,000	15,040	1,140	1 :345	1 :18·20	1 :4,605
Administration of Iodides.	24	...	...	...	143·78 each.	5,671,500	13,500	1,583	1 420	1 :8 ·5	1 :3,582
After Iodides	31	...	...	...	...	4,792,580	13,193	1,503	1 :363	1 :8 ·7	1 :3,188
Succeeding 6th Inoculation.	5	Bandicoot.	2·0	V. N.	...	3,820,000	14,360	2,040	1 266	1 :7 ·0	1 :1,872
Do. 7th Inoculation.	22		7·5	N.	...	3,785,000	24,463	8,182	1 :154	1 :7 ·6	1 :1,189

SUMMARY SHOWING THE NUMBER AND RATIOS OF THE CORPUSCULAR CONSTITUENTS OF THE BLOOD OF SURRA HORSES, SUBJECTED TO TREATMENT WITH ARSENIC AND IRON, TOGETHER WITH THE DAYS OF DISEASE AND TREATMENT, AND THE AMOUNT OF THE DRUGS ADMINISTERED WHEN A CURE WAS EFFECTED, AND WHEN DEATH FOLLOWED RESPECTIVELY.

(i) Corpuscular elements in health.

Horse—Mule—Donkey.

(ii) During treatment of Surra.

No. I.—Corpuscular Elements in Health.

According to Hayem, the blood of the horse in health contains 7,403,000 red, and 9,500 white corpuscles in cubic millimetre of blood, or a ratio of 1 : 779. The mean number of red corpuscles per cubic millimetre according to Smith is 7,212,500, but with regard to the white he states: "They exist in the proportion of 1 : 335 of red (Landois and Stirling), but vary in their proportion, according to the vessel from which the blood is examined." This would give a mean of 21,529 white in 1 cubic millimetre of blood.

In Poona, the following were the mean number of corpuscles recorded in the blood of healthy animals, during periods of observation varying in length :—

TABLE XXXVI.

Animal.	Mean of Observation. Days.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarse granular cells to white.	Ratio coarsely granular cells to red corpuscles.
Horse, gelding, aged...	15	8,256,000	7,800	1,493	1:1,058	1:5	1:5,529
Mule I, aged... ...	28	6,527,500	12,716	1,833	1: 591	1:6	1:3,561
Mule II, aged ...	28	6,480,000	10,964	2,621	1: 513	1:4	1:2,472
Donkey	57	5,249,000	15,995	2,095	1: 328	1:7	1:2,505
Donkey during administration of Iodides of Arsenic and Mercury	24	5,671,500	13,500	1,583	1: 420	1:8	1:3,582

No. II.—During treatment of Surra.

Horse CXV.—Entire, Persian, aged 4 years. CURED.

Day of Month.	Day of Disease.	Day of Treatment.	Total amount of Arsenic up to date.	Amount to date of Sodium, Iodide and Potass. Nit.	Red blood corpuscles.	White blood corpuscles.	Coarsely granular cells.	Remarks.
1894-5.			Grains.	Drachms.				
December 4 ..	26th	6	38	...	8,440,000	17,800	800	
12 ...	34th	14	127	...	8,280,000	9,600	1,000	
21 ...	43rd	23	217	...	8,100,000	5,600	400	40th day Temp. 103·3° F., 39·6° C.
30 ...	52nd	32	277	...	7,640,000	9,400	600	
January 9 ...	62nd	42	357	...	8,720,000	9,400	800	
19 ...	72nd	52	427	...	7,130,000	8,800	800	
28 ...	81st	61	465	...	9,480,000	10,000	600	
February 5 ...	89th	69	473	xvi KNO_3	9,300,000	9,200	600	
14 ...	98th	78	,,	iv	8,750,000	9,800	400	
22 ...	106th	86	,,	xiv	8,250,000	8,200	80	
March 3 ...	115th	95	,,	,,	8,160,000	6,400	200	5th. Crystals of hæmoglobin in the blood.
9 ...	121st	101	,,	,,	7,990,000	7,400	340	Cured.

This was a young entire horse, which had not been pulled down by the presence of the hæmatozoon to any great extent, although he had lost flesh.

In this case may be observed the gradual fall in the number of coarsely granular cells, a minimum was reached on the 86th day of treatment, after which there was a gradual rise until health ratio returned.

This animal was returned in March 1895 to the Bombay Mounted Police, and at present is said to be in good health and condition.

Horse No. CIX.—Entire, Persian, aged 9 years. Surra diagnosed 8th September 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles 1 c. mm.	White corpuscles 1 c. mm.	Coarsely granular cells 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	$FeSO_4$
1894.			Grains.	Grains.								
November 29 ...	83	25th ...	250	250	6,780,000	13,000	1,800	1 : 518	1 : 7·2	1 : 3,739	Absent.	...
December 7 ...	91	33rd ...	80	330	7,210,000	9,600	2,400	1 : 751	1 : 4·0	1 : 3,004	...	Ozs. i.
15 ...	99	41st ...	96	426	7,140,000	11,200	1,400	1 : 637	1 : 8·0	1 : 5,100	...	Ozs. ii.
24 ...	108	50th ..	56	482	5,000,000	9,000	200	1 : 555	1 : 45·0	1 : 25,000	...	Drs. xviii.
January 4 ...	119	61st ...	72	554	5,400,000	6,200	100	1 : 870	1: 62·0	1 : 54,000	...	Drs. v.
11 ...	126	69th ..	12	566	8,830,000	16,600	0	1 : 532	...	1 : ...	...	...

Hayem, G.—"Du Sang." Paris, 1889.
Smith, F. W.—"Veterinary Physiology." London, 1892.

Death 130th day of disease. Up to the 33rd day of the treatment, the red corpuscles were increased, white diminished, and coarsely granular cells increased, showing a healthy condition of the animal, but from that date until the 86th day there was a rapid decrease in the number of red corpuscles and coarsely granular cells. At death, there was a marked increase in the number of red and white corpuscles, and an entire absence of the coarsely granular cells.

Horse No. CX.—Entire, Persian, aged 9 years. Surra diagnosed 9th September 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles 1 c. mm.	White corpuscles 1 c. mm.	Coarsely granular cells 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	$FeSO_4$
1894.			Grains.	Grains.								
November 30 ...	83	26	240	240	8,220,000	5,400	2,000	1 : 1,522	1 : 2·7	1 : 4,110	Absent.	...
December 8 ..	91	34	51	291	8,510,000	5,200	1,400	1 : 1,636	1 : 3·7	1 : 6,078	...	...
,16 ...	99	42	30	321	7,900,000	11,800	0	1 : 670	1 : 295·0	1 : 19,750	....	Drs. iv

Death 103rd day of disease.

Horse No. CXI.—Entire, Persian, aged 5 years. Surra diagnosed 11th September 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles 1 c. mm.	White corpuscles 1 c. mm.	Coarsely granular cells 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	Remarks.
1894.			Grains.	Grains.								
December 1 ...	82	27	232·5	232·5	8,910,000	11,600	600	1 : 167	1 : 19·3	1 : 14,850	Absent.	
9 ...	90	35	64·0	296·5	8,250,000	8,800	0	1 : 937	1 : ...	1 : ...	...	
17 ...	98	43	108·5	405·0	8,070,000	7,800	200	1 : 1,034	1 : 39·0	1 : 40,350	...	
25 ...	106	51	27·0	432·0	8,260,000	14,800	0	1 : 558	1 :	...	...	

Death on 107th day of disease.

Horse No. CXII.—Persian gelding, aged 13 years. Naturally contracted Surra. Result—death, 23rd January 1895.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles 1 c. mm.	White corpuscles 1 c. mm.	Coarsely granular cells 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm.	$FeSO_4$
1894.			Grains.	Grains.								
December 3 ...	27	25	224	224	6,900,000	8,800	1,200	1 : 784	1 : 7·3	1 : 5,750	Absent.	...
11 ...	35	33	68·5	292·5	7,700,000	5,400	800	1 : 1,426	1 : 6·7	1 : 9,625	...	Dr. x
20 ...	44	42	90	382·5	8,060,000	4,600	600	1 : 1,752	1 : 7·6	1 : 13,433	...	...
January 5 ..	60	58	130	512·5	5,350,000	4,800	600	1 : 1,114	1 : 8·	1 : 8,916	...	Lymphangitis, near hind.
14 ...	69	67	48	560·5	5,870,000	3,600	0	1 : 1,630	...	...	...	...
23 ...	78	76	0	560·5	5,800,000	800	0	1 : 7,250	...	...	...	...

After the administration of Iron, there was an increase 4·4 per cent. in the number of red corpuscles, but after an attack of Lymphangitis, their number was rapidly reduced by 33·63 per cent. During the last 18 days the red corpuscles increased 16 %, but the white rapidly decreased, until at death the white were represented by 9% of the corpuscles at the first examination, and the coarsely granular cells had been entirely absent for more than two weeks.

Horse No. CXIII.—Entire, Persian, aged 5 years. Surra diagnosed 8th November 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles 1 c. mm.	White corpuscles 1 c. mm.	Coarsely granular cells 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	$FeSO_4$
			Grains.	Grains.								
December 5 ...	27	7	50·5	50·5	5,290,000	26,200	180	1 : 234	1 : 1,455	1 : 29,388	Absent.	
13 ...	35	15	87·0	137·5	6,980,000	37,000	0	1 : 188	...	...	...	

Horse No. CXIV.—Australian, entire, aged 5 years. 22nd November 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles 1 c. mm.	White corpuscles 1 c. mm.	Coarsely granular cells 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	$FeSO_4$
1894.			Grains.	Grains.								
4 ...	13	6	43	43	3,000,000	20,600	1,200	1 : 145	1 : 17·1	1 : 2,500	Absent.	
12 ...	21	14	50·5	93·5	5,550,000	26,600	0	1 : 206	...	...	...	

Death 21st day of disease.

Horse No. CXVI.—Australian gelding, aged 11 years. Surra diagnosed 29th November 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	$FeSO_4$
1894.			Grains.	Grains.								
December 3 ...	5	3	15	15	3,180,000	19,000	200	1 : 165	1 : 95·00	1 : 15.900	Absent.	
11 ...	13	11	100	115	5,260,000	15,200	0	1 : 346	...	...	...	Drs. vi December 4 to 7 (inclusive)

Horse No. CXVII.—Australian gelding, aged 9 years. Surra diagnosed 29th November 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	$FeSO_4$
			Grains.	Grains.								
3 ...	5	3	12	12	6,440,000	11,400	600	1 : 565	1 : 19·00	1 : 10,733	Absent.	
11 ...	13	11	78	90	9,940,000	14,600	0	1 : 680	...	...	...	
17 ...	19	17	24·5	114·5	.....	...	0	...	...	...	...	

Death 20th day of disease.

Horse No. CXVIII.—Australian gelding, aged 16 years. Surra diagnosed 3rd December 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	$FeSO_4$
			Grains.	Grains.								
December 5 ...	3	1	...	...	5,380,000	10,400	20	1 : 517	1 : 520·0	1 : 269,000	14,200	
13 ...	11	9	63·5	63·5	8,040,000	10,600	600	1 : 758	1 : 17·6	1 : 13,400	...	
22 ...	20	18	87·0	150·5	8,240,000	8,400	200	1 : 980	1 : 42·0	1 : 41·200	...	
28 ...	26	24	0	150·5	8,380,000	17,800	0	1 : 470	...	.....	...	

Death 28th day of disease.

Horse No. CXX.—Persian, entire, aged 7 years. Surra diagnosed 4th December 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Arsenic administered between dates.	Total Arsenic to date.	Red corpuscles in 1 c. mm.	White corpuscles in in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white cles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	
1894.			Grains.	Grains.								
December 10 ...	7	1	...	...	5,050,000	13,000	200	1 : 388	1 : 65·0	1 : 25,250	Absent.	
18 ...	15	9	78	78	5,460,000	11,600	200	1 : 469	1 : 58·0	1 : 27,250	...	
26 ...	23	17	0	78	5,110,000	10,000	600	1 : 511	1 : 16·6	1 : 8,516	...	
January 6 ...	34	28	62	140	3,450,000	8,600	200	1 : 770	1 : 43·0	1 : 17,250	...	
14 ...	42	36	54	194	.....	...	0	...	...	.....	...	

Horse No. CXIX.—Herati gelding, aged 8 years. Surra diagnosed 4th December 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Total amount Arsenic up to each date.	Red blood corpuscles 1 c. mm.	White blood corpuscles 1 c. mm.	Coarsely granular corpuscles 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm.
1894.			Grains.							
December 6 ...	4	1st ...	...	7,400,000	10,000	0	1 : 740	...	...	5,600
14 ...	12	9th ...	52	7,910,000	9,600	50	1 : 824	1 : 192·0	1 : 158,200	Absent.
23 ...	21	18th ...	147	8,070,000	7,800	600	1 : 1,034	1 : 13·0	1 : 13,450	...
31 ...	29	26th ...	203	7,860,000	3,600	600	1 : 2,183	1 : 6·0	1 : 13,100	...
1895.										
January 9 ...	38	35th ...	334	7,970,000	4,400	800	1 : 1,811	1 : 5·5	1 : 9,962	...
18 ...	47	44th ...	415	9,960,000	8,600	1,900	1 : 926	1 : 3·6	1 : 7,960	...
26 ...	55	52nd ...	463	6,200,000	3,800	200	1 : 1,631	1 : 19·0	1 : 31,000	...
February 8 ...	63	60th ...	501	6,740,000	4,800	300	1 : 1,404	1 : 24·0	1 : 33,700	...
11 ...	71	68th ...	537	6,630,000	5,800	130	1 : 1,152	1 : 44·60	1 : 51,384	...
19 ...	79	76th ...	563	6,200,000	11,200	70	1 : 620	1 : 160·0	1 : 88,571	1,960
27 ...	87	84th ...	655	6,940,000	5,800	0	1 : 1,196	...	...	Absent.
March 9 ...	97	94th ...	670	6,500,000	12,200	0	1 : 533	...	...	...
18 ...	106	103rd ...	772	7,930,000	5,600	0	1 : 1,416	...	...	...
26 ...	114	111th ...	772	5,420,000	7,000	400	1 : 774	1 : 17·5	1 : 13,550	...
April 3 ...	122	119th ...	790	6,640,000	3,800	200	1 : 1,747	1 : 19·0	1 : 33,200	...
12 ...	131	128th ...	868	8,350,000	9,800	20	1 : 852	1 : 490·0	1 : 417,500	...
23 ...	142 *	139th * ...	957 *	7,500,000	9,600	0	1 : 781	...	...	...
July 2 ...	212	209th ...	2,110	Death occurred.						736

Further observations were discontinued after 23rd April 1895 owing to the transference of the Laboratory effects from Poona to the new premises in the Himalayas.

Horse No. CXXII.—Entire, Persian, aged 6 years. Surra diagnosed 28th November 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Amount of Arsenic between each date.	Total Arsenic to date.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm.	Remarks.
1894.			Grains.	Grains.								
December 10 ...	13	1	...	...	8,860,000	12,800	400	1 : 301	1 : 32·0	1 : 9,650	2,112	
19 ...	22	10	106	106	7,050,000	13,600	400	1 : 518	1 : 34·0	1 : 17,625	...	
26 ...	29	17	24	130	6,920,000	7,400	600	1 : 935	1 : 12·3	1 : 11,533	...	
1895.												
January 7 ...	41	29	97	227	6,800,000	9,600	1,600	1 : 708	1 : 6·0	1 : 4,250	...	
17 ...	51	39	102	329	9,140,000	18,000	3,000	1 : 508	1 : 6·0	1 : 3,046	...	
25 ...	59	47	9	338	8,240,000	9,200	40	1 : 896	1 : 230·0	1 : 206,000	...	
February 2 ...	67	55	28	366	6,920,000	5,200	800	1 : 1,338	1 : 6·5	1 : 8,650	10	NaI, drs. viii.
10 ...	75	63	60	426	7,680,000	8,400	800	1 : 914	1 : 10·5	1 : 9,600	...	,, drs. iv.
18 ...	83	71	82	508	8,050,000	5,200	40	1 : 1,548	1 : 130·0	1 : 201,250	...	
26 ...	91	79	84	592	8,900,000	7,800	400	1 : 1,141	1 : 19·5	1 : 22,250	...	
March 6 ...	99	87	23	615	6,280,000	5,600	1,600	1 : 1,121	1 : 3·5	1 : 3,925	...	
15 ...	108	96	92	707	7,970,000	4,400	800	1 : 1,811	1 : 5·5	1 : 9,963	...	
24 ...	117	105	35	742	8,990,000	11,000	1,000	1 : 817	1 : 11·0	1 : 8,990	10	
April 1 ...	125	113	12	754	7,650,000	7,800	400	1 : 981	1 : 19·5	1 : 19,125	...	
11 ...	135	123	60	814	7,080,000	8,200	1,400	1 : 863	1 : 5·8	1 : 5,057	23	
24 ...	148*	136	21	835	8,010,000	13,400	0	1 : 435	...	...	1,856	
		C HCl 3										

* Death.

Horse No. CXXIII.—Entire, Persian, aged 6 years. Surra diagnosed 7th December 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Amount of Arsenic administered between each date.	Total Arsenic up to date.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm.	Remarks.
1894.			Grains.	Grains.								
cember 23 ...	17	1	...	...	4,790,000	15,600	55	1 : 307	1 : 283·6	1 : 87,091	2,600	
1895.												
January 3 ...	28	12	135	135	8,360,000	6,600	166	1 : 1,266	1 : 39·7	1 : 50,361	Absent.	
11 ...	36	20	7	142	6,410,000	7,800	800	1 : 821	1 : 9·7	1 : 8,012	...	
21 ...	46	30	78	220	6,780,000	3,800	1,400	1 : 1,789	1 : 2·7	1 : 4,843	...	
29 ...	54	38	60	280	6,390,000	6,000	800	1 : 1,065	1 : 7·5	1 : 7,987	...	
February 6 ...	62	46	32	312	6,530,000	2,800	400	1 : 2,332	1 : 7·0	1 : 16,325	...	
15 ...	71	55	51	363	6,710,000	5,000	0	1 : 1,342	...	...	5*	*69th day of disease
23 ...	79	63	90	453	6,170,000	10,800	1,000	1 : 664	1 : 10·8	1 : 7,170	Absent	
March 4 ...	88	72	102	555	6,310,000	6,200	200	1 : 1,018	1 : 31·0	1 : 31,500	...	
13 ...	97	81	25	580	6,200,000	7,600	0	1 : 816	...	...	840	

Death on 82nd day of treatment.

Horse No. CXXIV.—Entire, Persian, aged 7 years. Surra diagnosed 7th December 1894.

Day of Month.	Day of Disease.	Day of Treatment.	Amount of Arsenic between dates.	Total Arsenic to date.	Red corpuscles in 1 c. mm.	White corpuscles in 1 c. mm.	Coarsely granular cells in 1 c. mm.	Ratio white to red corpuscles.	Ratio coarsely granular to white corpuscles.	Ratio coarsely granular to red corpuscles.	Hæmatozoa in 1 c. mm. blood.	Remarks.
1894.			Grains.	Grains.								
December 23 ...	17	1	...	...	4,640,000	14,800	1,200	1 : 313	1 : 12·3	1 : 3,866	1,260	
1895.												
January 3 ...	27	11	121	121	5,660,000	8,200	200	1 : 678	1 : 41·0	1 : 27,800	Absent.	
10 ...	35	19	56	177	7,580,000	10,200	800	1 : 743	1 : 12·7	1 : 9,475	...	
18 ...	43	27	36·5	213·5	8,330,000	10,600	400	1 : 786	1 : 26·5	1 : 20,825	...	
27 ...	52	36	96	309·5	8,780,000	7,200	200	1 : 1,219	1 : 36·0	1 : 43,900	...	
February 4 ...	60	44	56	365·5	8,190,000	9,000	400	1 : 910	1 : 22·5	1 : 20,475	...	
8 ...	64	48	34	389·5			20	...	...	...		

Death on the 64th day of disease.

SUMMARY OF THE NUMBER AND RATIOS OF THE CORPUSCULAR CONSTITUENTS OF THE BLOOD OF GUINEA PIGS, BEFORE AND AFTER INOCULATION WITH SURRA BLOOD, TOGETHER WITH A TABLE SHOWING THE RESULTS WHEN THE PAROXYSMS AND INTERMISSIONS ARE MASSED TOGETHER.

Guinea Pig I. Table—Remarks.
„ „ II. Do. do.

Guinea Pig No. I. TABLE XXXVII.

Periods.	Days.	Red corpuscles.	White corpuscles.	Coarsely granular corpuscles.	Ratio white to red corpuscles 1 :	Ratio coarsely granular to white corpuscles 1 :	Ratio coarsely granular to red corpuscles 1 :	Hæmatozoa mean in different periods in 1 c. mm. blood.
Health	10	5,552,000	14,200	460·	390	31	12,069	...
Latent Period	6	5,350,000	12,666	267·6	422	47	19,992	...
Paroxysm I ...	4	5,180,000	7,063	116·5	73	61	44,463	67
Intermission I ...	4	5,040,000	9,470	253·0	532	37	19,921	...
Paroxysm II ...	11	5,013,666	6,744	107·0	743	63	46,856	3,856
Intermission II ...	3	4 753,221	5,643	206·0	842	27	23,074	..
Paroxysm III ...	35	4,928,769	3,769	172·7	1,307	22	28,539	5,018
Intermission III ...	1	4,330,000	1,999	178·0	2,161	11	24,326	...
Paroxysm IV ...	6	4,498,333	4,391·3	100·6	1,024	43	44,715	840
Intermission IV ...	2	4,820,000	7,800	140·0	618	55	34,429	...
Paroxysm V ...	12	4,355,000	4,733	34·0	920	139	128,088	1,492
Intermission V ...	1	4,240,000	7,000	0	605	0	0	...
Paroxysm VI ...	9	4,361,111	5,177	28·6	842	181	152,486	1,941
Intermission VI ...	2	4,470,000	3,000	30·0	1,490	100	149,000	...
Paroxysm VII ...	2	4,770,000	7,500	121·5	636	62	39,259	23·5
Intermission VII ...	3	5,246,666	8,600	585·3	610	15	8,964	...
Paroxysm VIII ...	13	5,079,569	4,815	182·2	1,055	27	27,879	777
Intermission VIII ...	1	4,890,000	5,000	143·0	978	35	34,195	...
Paroxysm IX ...	2	5,020,000	5,800	151·5	865	38	33,069	44·5
Intermission IX ...	3	4,936,666	4,933	4'2·7	1,000	12	11,961	...
Paroxysm X ...	3	5,030,000	7,800	131·3	644	59	38,309	168
Intermission X ...	1	4,990,000	5,400	238·0	924	23	20,966	...
Paroxysm XI ...	15	5,456,666	6,746	41·6	808	162	131,171	2,475

Days.	Periods.	Red corpuscles.	White corpuscles.	Coarsely granular corpuscles.	Hæmatozoa in 1 c. mm.
10	Health	5,552,000	14,200	460	...
6	Latent period ...	5,350,000	12,666	267	...
112	Paroxysms	4,881,192	5,867	107	1,518
21	Intermissions ...	4,771,655	5,884	218	...
149	Whole period ...	4,960,075	6,263	165	...

Remarks.—In the table showing the mean number of corpuscles during the massed periods, it will be observed that the number of *red corpuscles* gradually fell during each period, until in the intermissions there was a loss of 14 % compared with health.

The greatest loss suffered by the *white* during the paroxysm, was equal to nearly 59 %. There was a slight attempt to recuperate during the intermissions, but as the ratio of the relative periods, intermissions to paroxysms is 1 : 5·33, the time was too limited.

The *coarsely granular cells* were rapidly reduced in numbers, even during the latent period, but during the presence of the hæmatozoon they fell nearly 77 %, but gained 29% during the intermissions. They were absent during the fifth intermission, and also at the time of death.

TABLE XXXVIII.

Guinea Pig No. II.

Periods.	Days.	Red corpuscles.	White corpuscles.	Coarsely granular corpuscles.	Ratio white to red corpuscles 1 :	Ratio coarsely granular to white corpuscles 1 :	Ratio coarsely granular to red corpuscles 1 :	Hæmatozoa. Mean in different periods in 1 c. mm. blood.
Health	31	5,649,032	14,566	81	387	179	69,741	...
Latent Period	6	5,411,666	10,118	297	535	34	18,221	...
Paroxysm I	7	5,275,714	5,203	52	1,014	100	101,456	3,780
Intermission I	2	5,080,000	11,071	...	459	...	...	...
Paroxysm II	6	5,041,666	4,285	...	1,176	...	...	12,180

Periods.	Red corpuscles.	White corpuscles.	Coarsely granular corpuscles.	Hæmatozoa in 1 c mm.
Health	5,645,032	14,566	81	...
Latent Period	5,411,666	10,118	297	...
Paroxysms	5,167,692	4,779	52	7,980
Intermission	5,080,000	11,071	...	...
Whole Period	5,479,423	11,472	105	...

Guinea Pig inoculated from Horse No. CVII.

Remarks.—This animal succumbed somewhat suddenly to a ruptured liver—probably through accident—on the 15th day of the disease.

Red Corpuscles.—These diminished in number gradually from the latent period, and at the time of death the loss compared with health was equal to 10·8 %.

The *white corpuscles* decreased during the period of incubation 30 %, but the mean loss of the two paroxysms was 70 %, compared with the health standard, but when the hæmatozoa disappeared from the blood, and the temperature fell during the intermission, although it only lasted two days, 46 % of the white cells returned. But it is worthy of notice, that during the same period the red corpuscles were unable to recuperate.

Coarsely Granular Cells.—The mean of the latent period exceeds that of health nearly four times, but on the appearance of the hæmatozoon their numbers were rapidly reduced, and these cells finally disappeared altogether in the first intermission.

NOTES ON THE NUMBER OF HÆMATOZOA, RED AND WHITE CORPUSCLES, IN EACH CUBIC MILLIMETRE OF BLOOD OF RATS AND BANDICOOTS, TOGETHER WITH THE ANIMALS' BODY-WEIGHT AND THAT OF THE PRINCIPAL ORGANS.

(i) Rat (*Mus decumanus*).

(ii) Bandicoots [*Mus (Nesokia) giganteus*].

TABLE XXXIX

Showing the number of Hæmatozoa, Red and White Corpuscles, in one cubic millimetre of the blood of Rats (Mus decumanus) together with their body-weight and that of the principal organs and their respective ratios.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Serial No.	No. in Case Book		Hæmatozoa in blood 1 c. mm.	Numbar of red corpuscles in 1 c. mm. of blood.	Number of white corpuscles in 1 c. mm.	Ratio white corpuscles to red.	Ratio hæmatozoa to red corpuscles.	Body weight of Rat.	Spleen weight	Ratio of spleen weight to body weight.
								Grammes.	Grammes.	
1	1406	N	6,233	6,350,000	4,400	1 : 1,443	1 : 1016	85·0	1·70	1 : 50
2	1140	VN	9,400	6,320,000	2,600	1 : 2,431	1 : 672	28·0	0·05	1 : 560
3	1404	VN	11,200	6,970,000	8,600	1 : 810	1 : 522	51·0	0·25	1 : 204
4	1402	VN	15,000	7,550,000	5,200	1 : 1,452	1 : 503	58·0	0·25	1 : 232
5	1156	T	51,200	4,850,000	11,000	1 : 441	1 : 95	58·0	1·45	1 : 40
6	1171	T	268,400	5,450,000	6,000	1 : 915	1 : 20	28·0	0·29	1 : 96
7	1417	T	292,000	6,060,000	19,000	1 : 319	1 : 21	42·0	0·71	1 : 59

TABLE XL

Showing the number of Hæmatozoa, Red and White Corpuscles in one cubic millimetre of the blood of Bandicoots [Mus (Nesokia) giganteus], &c.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Serial No.	No. Laboratory Case Book.	Hæmatozoa in blood 1 c. mm.		Red corpuscles in blood 1 c. mm.	White corpuscles in 1 c.mm.	Ratio white corpuscles to red corpuscles.	Ratio hæmatozoa to red corpuscles.	Body weight.	Spleen weight	Liver weight.	Ratio spleen weight to body weight.	Ratio liver weight to body weight.
1	123	664	F	6,660,000	12,600	1 : 528	1 : 10,030	772	4·40	77·6	1 : 175	1 : 20·5
2	120	2,400	F	6,200,000	19,400	1 : 319	1 : 2,583	837	3·00	26·9	1 : 279	1 : 31·1
3	117	35,500	S	5,850,000	6,600	1 : 889	1 : 164	555	1·70	20·9	1 : 326	1 : 26·5
4	118	36,000	S	5,400,000	3,600	1 : 1,500	1 : 150	211	0·70	9·90	1 : 301	1 : 21·3
5	112	101,000	T	4,110,000	10,500	1 : 391	1 : 40·7	142	0·60	10·7	1 : 236	1 : 13·2
6	109	293,000	T	7,190,000	12,500	1 : 590	1 : 24·5	83	0·85	6·80	1 : 97·6	1 : 12·2
7	111	349,550	T	5,940,000	32,600	1 : 182	1 : 16·9	128	0·70	7·2	1 : 183	1 : 17·7

SUMMARY OF CORPUSCULAR CHANGES IN THE BLOOD.

The changes observed with regard to the number of red, white and coarsely granular oxyphile cells in the blood—

(i) When Surra has been acquired naturally, or by experimental inoculation.

(ii) After unsuccessful inoculation with the bandicoot hæmatozoon

(iii) During the period of treatment of Surra with Arsenic.

RED CORPUSCLES.

(i) *When Surra acquired naturally or by inoculation.*—An increase in the number of red corpuscles occurred in the latent period, equal to 9·7 % in the horse, and 5 and 1·87, respectively, in the mules. During the paroxysms there was a decrease, most marked in the case of the mules. A further decrease occurred in the intermissions, except in the case of Mule II.

TABLE XLI.

Showing the percentages of Red Corpuscles, taken on the mean daily number in the blood of the Horse and Mule, during different periods of health and disease (Surra).

Periods.	Length in Days.	Horse No. LXXXIX.	Length in Days.	Mule I.	Length in Days.	Mule II.
		%		%		%
Health	15	100·00	28	100·00	28	100·00
Latent period	7	109·70	11	105·00	8	101·87
Paroxysms...	47	86·01	49	61·34	39	65·17
Intermissions	5	74·98	26	52·35	14	67·17
Whole period	74	87·16	114	68·67	89	79·74

(ii) *After unsuccessful inoculation with the Bandicoot hæmatozoon.*—Taking the mean of five inoculations (donkey), the effect produced 24 hours after inoculation was to increase the number of red corpuscles 10·48 %, whilst at the end of 72 hours a reduction in their numbers equal to 11·79 %. had taken place.

(iii) *Treatment of Surra Animals with Arsenic.*—In horses, after an interval of several days, from the 9th to 12th day of treatment, a considerable increase in the number of red corpuscles took place, in some cases approaching 70 to 100 %. This rise was followed by a fairly gradual decrease, which in a mean of 8 cases was found to commence on the 41st day of treatment, after 403·4 grains of arsenic had been administered. A secondary increase in the numbers recorded, occurred just before death in 5 out of 8 cases.

WHITE CORPUSCLES.

(i) *When Surra acquired naturally or by inoculation.*—A decrease in the number of white corpuscles took place during the period of incubation, varying from 8 to 25 per cent. During the paroxysms an increase occurred, which in the mule was enormously added to during the intermissions. In No. LXXXIX Horse, the length of intermissions compared with the paroxysms were as 1 : 9·4, whereas in the mules they were as 1 : 1·9, and 1 : 2·8 respectively.

TABLE XLII

Showing the percentages of White Corpuscles, taken on the mean daily number, in the blood of the Horse and Mule, during different periods of health and disease (Surra).

Periods.	Length in Days.	Horse No. LXXXIX.	Length in Days.	Mule I.	Length in Days.	Mule II.
		%		%		%
Health	15	100·00	28	100·00	28	100·00
Latent period	7	91·20	11	89·93	8	74·56
Paroxysms	47	142·89	49	100·69	39	111·73
Intermissions	5	141·02	26	135·31	14	130·38
Whole period	74	134·23	114	108·66	89	107·61

(ii) *After unsuccessful inoculation with the Bandicoot hæmatozoon.*—Taking the mean of five inoculations, the effect produced (in the donkey) 24 hours after, was to increase the white corpuscles by 76 %, whilst at the end of 72 hours a reduction of 69 % of the increase had occurred.

(iii) *Treatment of Surra with Arsenic.*—In the case successfully treated with Arsenic, the number of white corpuscles rapidly decreased, and never attained during recovery within 75 % of the number present at the commencement of treatment. A similar reduction was observed to take place in the course of the fatal cases, when the system of the animal became influenced by the drug. Fluctuations in the number of the white corpuscles, however, occurred, which did not appear to correspond with any rise or fall in the number of red or the coarsely granular oxyphile cells. In the majority of cases recorded, shortly before death a considerable increase in the number of white corpuscles took place, concurrently with the rise in red.

COARSELY GRANULAR OXYPHILE CELLS (EOSINOPHILE CELLS).

(i) *When Surra acquired naturally or by inoculation.*—A great diminution in the number of coarsely granular cells was observed during the latent period, but the greatest decrease in their numbers was observed during the paroxysms of Surra, in the majority of cases. When the intermissions were sufficiently prolonged, there was a rapid increase in the number of these cells, during the absence of the hæmatozoon from the circulation, and the consequent fall in temperature.

TABLE XLIII.

Showing the Percentages of coarsely granular Oxyphile Cells, taken on the mean daily number, in the blood of the Horse and Mule during different periods of health and disease (Surra).

Periods.	Length in Days.	Horse No. LXXXIX.	Length in Days.	Mule I.	Length in Days.	Mule II.
		%		%		%
Health	15	100·00	28	100·00	28	100·00
Latent period	7	72·67	11	86·30	8	65·81
Paroxysms...	47	41·12	49	14·78	39	39·52
Intermissions	5	82·58	26	12·16	14	56·65
Whole period	74	63·89	114	33·27	89	63·60

(ii) *After unsuccessful inoculation with the Bandicoot hæmatozoon.*—When the animal inoculated is in good health, there is always a great increase in the number of these cells, varying between 24 and 36 %

(iii) *Treatment of Surra with Arsenic.*—There is nearly always a steady increase in the number of the coarsely granular oxyphile cells, commencing shortly after the administration of the drug, but attaining a maximum after varying amounts have been given.

In these cases, where arsenic is pushed, and death supervenes, there is a gradual decrease, until at the time of death these cells are very few in number, or more frequently absent. In the event of the animal under treatment recovering, the cells decrease in number, until they reach a minimum, when they gradually increase until they attain the ratio found in health.

One can make a fair prognosis as to an animal's chance of recovery from Surra, by daily observing the number of coarsely granular oxyphile cells present in (one cubic millimetre of) its blood.

SOME NOTES ON THE AMOUNT OF UREA AND HIPPURIC ACID EXCRETED IN THE URINE DURING HEALTH AND THE PHASES OF UNTREATED AND TREATED SURRA.

It is very difficult to draw definite conclusions with regard to the excretion of urea in paroxysms and intermissions, owing to the fact that the maximum amount of urea is passed at varying times after the highest temperature has been reached. The maximum temperature sometimes occurs in the middle of a paroxysm, when, as a rule, the urea would be recorded during that period, whilst at others the highest temperature occurs, just before the disappearance of the organism, *i.e.* at the end of the paroxysm, in which cases the maximum amount of urea appears in the succeeding intermission.

On reference to the following table the amount of urea, in grammes, excreted by each animal during health and disease, will be observed under the different headings of Untreated, Treated or Preliminary Treatment.

TABLE XLIV

Showing the mean daily amount of Urea in grammes, excreted in the urine during periods of health preliminary treatment, and after the inoculation and subsequent treatment of Surra.

Treated or untreated.	Animals.	Health.	Preliminary Treatment	Latent Period.	Paroxysms.	Intermissions.	Arsenical Treatment	Iodides of Arsenic and Mercury.	Period of convalescence.	Mean daily walking exercise.	Remarks.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	
Untreated	Horse No. XCII ...	17·68	...	23·25	61·68	79·89	...	...	...	*Nil.*	
	„ „ XCIII ...	46·64	...	44·24	99·82	68·98	...	...	...	*Nil.*	
Treated ...	„ „ XCI ...	...	...	...	99·91	41·36				*Nil.*	
	„ „ LXXXIX (I Series).	21·42	...	19·71	52·90		28·71	86·53	94·93	* 5·06	*For 182 days.
	„ „ XCVI ...	...	...	82·93	192·39	143·95	...	...	...	*Nil.*	
Preliminary Treatment.	„ „ XCVIII...	31·95	73·09	62·37	91·92	87·33	...	...	...	*Nil.*	
	„ „ XCIX ...	38·89	75·09	82·05	156·82	124·95	...	...	...	*Nil.*	
Untreated	„ „ LXXXIX (II Series).	115·89	...	147·46	206·42	190·11	...	...	...	† 5·35	†First 60 out of 73 days.
	Mule No. I	91·24	...	75·62	51·06	49·77	...	...	...	2·03	
	„ „ II	29·54	...	28·86	52·02	65·75	...	...	...	3·78	

Periods.	Succeeding 1st Inoculation.	Succeeding 1st Inoculation.	Observation.	Succeeding 2nd Inoculation.	Succeeding 2nd Inoculation.	Succeeding 3rd Inoculation.	Succeeding 4th Inoculation.	Succeeding 5th Inoculation.	Observation.	Administered Iodides.	After Iodides.	Succeeding 6th Inoculation.	Succeeding 7th Inoculation.
Days.	6	23	57	8	29	3	5	5	10	24	31	5	22
	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Donkey ...	23·78	19·30	19·59	22·39	16·95	12·49	10·65	13·37	10·02	11·22	14·43	16·42	18·61

Hippuric Acid.—With regard to the presence of hippuric acid in the urine of the horse and mule, it will be noted, on reference to the accompanying table, that in health and at rest, the amount of this acid excreted varied very greatly, and in two animals (Nos. XCI and XCVI) it was absent altogether. In the same horse (LXXXIX) having almost the same amount of exercise, the hippuric acid was as 1 : 2 in different years. In the case of the two mules under observation, the amount was as 1 : 19·74. During the latent period, the hippuric acid excreted by the *untreated* animals increased in amount in three out of five cases, remained stationary in one, and the quantity decreased in one; but in all five animals, there was a decrease from the latent period during the paroxysms and intermissions. In those animals treated after inoculation, the effect produced by the administration of arsenic was the reverse of the above—considerable quantities being passed during the paroxysms and intermissions of the disease.

The effect of the preliminary treatment (Horses Nos. XCVIII, XCIX) with Arsenic and the double Iodides of Arsenic and Mercury, was to reduce the hippuric acid from 3·1 and 1·5 respectively to 1, and to stop its excretion altogether during the remainder of the periods the animals lived.

The effect of Arsenic as Liq. Arsenicalis on the excretion of hippuric acid in the horse, would appear to be a slight reduction in the amount, whereas the effect of the Iodides of Arsenic and Mercury is to reduce the hippuric acid to a minimum, and when the drug is left off, to stop the excretion of it altogether for a time.

In the case of the animal LXXXIX, which received the double iodides during convalescence from Surra, the effect produced was to reduce the amount of hippuric acid excreted during the administration of the drug; but when the iodides were discontinued, the excretion ceased altogether for a considerable time, *viz.*, 163 days.

Donkey.—There was usually a decrease in the amount of hippuric acid excreted after unsuccessful inoculation, but the quantity again rose during the period succeeding. During the administration of the Iodides of Arsenic and Mercury, the amount was reduced by 33 %; after the discontinuance of the drugs there was a still further reduction, which when compared with that excreted during the period of observation, amounted to 81·07 %.

Table XLV

Showing the mean daily amount, in grammes, of Hippuric Acid excreted in the urine during periods of health, preliminary treatment, and after the inoculation and subsequent treatment of Surra.

Treated or untreated.	Animals.	Health.	Preliminary Treatment.	Latent Period.	Paroxysms.	Intermissions.	Arsenical Treatment.	Iodides of Arsenic and Mercury.	Period of convalescence.	Mean daily walking exercise.	Remarks.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Miles.	
Untreated ...	Horse No. XCII ...	7·88	...	12·22	1·36	0·36	...	...	...	*Nil.*	
	„ „ XCIH ...	3·48	...	3·48	2·79	0·00	...	...	...	*Nil.*	
Treated	„ „ XCI ...	0·00	...	0·00	15·02	12·87	...	...	...	*Nil.*	
	„ „ XCVI ...	0·00	...	7·19	4·58	6·24	...	...	...	*Nil.*	
	„ „ LXXXIX (I Series).	11·08	...	18·62	12·49	...	16·14	2·18	*Nil 14·87	† 5·06	* 163 days *nil* 63 „ 14·87. † For 182 days.
Preliminary Treatment.	„ „ XCVIII.	12·83	3·94	...	...	...	...	...	...	*Nil.*	
	„ „ XCIX ...	13·14	8·75	...	...	...	...	...	...	*Nil.*	
	„ „ LXXXIX. (II Series).	21·46	...	15·73	3·79	...	...	...	...	‡ 5·35	‡ First 60 out of 73 days.
Untreated ...	Mule No. I... ...	1·37	...	10·15	3·48	6·24	...	...	...	§ 2·03	§ Four paroxysms and one intermission out of 11 paroxysms and 10 intermissions.
	„ „ II ...	27·05	...	27·94	6·60	...	...	...	...	3·78	

FURTHER NOTES CONNECTED WITH THE ETIOLOGY OF SURRA.

The course of this disease (Surra) is characterized by two kinds of periods: (i) *Paroxysms*, during which the hæmatozoon (Trypanosoma Evansi) is present in varying numbers, from 1 to 350,000 in each cubic millimetre of blood: (ii) *Intermissions*, during which the hæmatozoon is absent.

It may be stated, as a rule, that in all animals, the greater the number of hæmatozoa present in the circulation during a paroxysm, the shorter will be the duration of such period. The duration of a paroxysmal period in India varies between three and ten days, according to the animal attacked. In experimental animals (horses), when the disease has been transmitted by means of a trace of soiled blood placed in a slight superficial scratch, the paroxysms may last as long as 22 days, but the organisms rarely exceed 400 in each cubic millimetre of blood.

Although during the *intermissions* of Surra, the most careful microscopical examination of the blood has failed to discover the presence of a single hæmatozoon, nevertheless during such a period, lasting five days for instance, if a fresh guinea pig be inoculated with a like quantity of blood (0·3 c.c.) on each of the days making up the period, it generally happens that four out of the five animals will contract Surra. The blood extracted on the first or second day of the intermission, is the sample which fails to reproduce the disease in the guinea pigs. The period of incubation after such inoculation, however, varies considerably in length in animals of the same species. In one experiment when the blood of the second day of the intermission failed to reproduce the disease, the latent period in the third guinea pig was 19·5 days, in the fourth guinea pig 8·5 days, and in the fifth animal 6·5 days, whereas in ordinary inoculations, guinea pigs injected subcutaneously with soiled Surra blood from the horse, contract the disease in from four to five days.

Successful inoculations have been made with blood taken from horses, which succumbed to Surra, up to 18 hours *post mortem*, but not later.

It has been previously noted, that the changes brought about in the blood by the hæmatozoon in Surra cases are—(i) high temperature, maximum 108°F.; (ii) rapid reduction in the number of red corpuscles in the blood; (iii) an increase in the number of white corpuscles; (iv) decrease in the number of coarsely granular oxyphile cells; (v) a diminution in the amount of hæmoglobin concurrently takes place, most marked during the paroxysmal periods.

When a Surra animal (horse) is treated with arsenic, the hæmatozoon disappears from the blood after a varying amount of the drug has been administered. The body temperature falls and reaches normal limits, and the animal frequently maintains its condition, sometimes putting on flesh. The red blood corpuscles increase in number, and again from normal rouleaux, a diminution in the number of white corpuscles, and an increase in the number of coarsely granular corpuscles takes place.

Inoculation has been successfully performed with blood drawn from an animal previously submitted to arsenic for a few days, from whose blood the hæmatozoon was absent; but after the ninth day of treatment, the immature form of the organism, if such it be, appears to be acted upon by the drug, for negative results then follow inoculation with the blood of the animal under treatment. There is, however, a tendency for the Surra hæmatozoon to re-appear in the blood of the animal subjected to arsenic, after an absence of about 25, 50, or 75 days.

In continuation of the experiments recorded in 1893, *viz.*, the efficacy of repeated injections of serum, obtained from bovines directly after severe attacks of Surra, when injected into equines suffering from that disease, further researches were initiated in small animals (rabbit and guinea pig), the injected serum being obtained from bandicoots [Mus (Nesokia) giganteus] just previously the subjects of the hæmatozoa. The injections of serum in the case of the rabbit, seemed to retard the appearance of the hæmatozoon in the blood, for the average length of the latent period of Surra in this animal was found to be about 8½ days, whereas in those experiments it occupied an average of 28 days. In the guinea pig the latent period occupied the usual time, but the injections of serum appear to have been the cause of shortening the period of life.

Sweat.—In regard to the calculations on sweat in this report, the amount taken was based on estimations by Grandeau and Leclerc on horses in Europe. From these experiments it was found that 6·4 lbs. were excreted daily at rest, and 13·4 lbs. when trotting. F. Smith, quoting Colin, gives 14 lbs. as the probable loss in 24 hours, and this figure has been taken for our experiments as most probably representing the loss in a tropical climate like Poona. The sweat figures therefore are not given as scientifically accurate, but are sufficiently close to only interfere very slightly with the other questions at issue.

In the case of the mules an average of 9·6 lbs. daily was taken. All the animals under experiment were thoroughly groomed twice daily.

Digestion.—A voracious appetite is one of the marked systems of animals suffering from Surra, and they frequently die with their mouths full of grain or fodder. In the three cases under experiment, *viz.* Horse No. LXXXIX (2nd Series) and Mules I and II, the digestive

power increased throughout the course of the disease, but was especially marked in the intermissions, when the organism was absent, and the temperature consequently low. *Vide* Tables XV, XXII and XXVIII.

Effect of Iodides on Urea, &c.—A point of interest and utility to be observed in this investigation is the enormous effect of the Iodides of Arsenic and Mercury in animals on the excretion of urine, urea, and hippuric acid. In the case of the urine and urea, the first effect was observed some three weeks after the administration of the drug commenced. The excretion increased considerably while the drug was being given, but the full effect did not occur until after it had been discontinued. *Vide* Table III, page 18.

Arsenic as Liquor Arsenicalis, administered to equines, diminishes the output of urea, but tends to favour the excretion of hippuric acid, which in untreated cases practically ceases early in the disease. The iodides also produced a marked effect on the corpuscular elements in the blood of the Donkey, increasing the red, and decreasing the white and coarsely granular oxyphile cells. *Vide* Table XXXVI.

Water Excretion.—A point of interest to be noted is the manner in which water excreted as urine and in dung, varies in an inverse ratio throughout the course of the disease (Surra). The amount excreted as urine increased, and that of the dung decreased, whilst that by the lungs and skin remained practically stationary. In contra-distinction to the above, in animals not the subjects of Surra, but which had been subjected to the iodides, both the water in the urine and dung decreased, while that by the lungs and skin increased considerably.

TABLE XLVI.

Showing the inverse ratio of the percentage of water excreted as urine, and in dung: 1st in animals the subjects of Surra, 2nd in healthy animals after treatment with the Iodides of Arsenic and Mercury.

	Animals.	Periods of observation.	Urine c/°	In dung c/°	By lungs and skin c/°
Surra Animals	Horse LXXXIX... (2nd Series)	Health	18·57	43·29	38·14
		At death	32·08	31·36	36·56
	Mule I	Health	11·45	46·11	42·44
		At death	57·55	0·72	41·73
	Mule II...	Health	10·49	46·31	43·20
		At death	19·01	28·14	52·85
Healthy Animals	Horse LXXXIX... (1st Series)	1st week	27·82	52·17	20·01
		26th week	17·00	51·25	31·75
	Donkey IV	1st week	29·43	35·73	34·84
		8th week (after iodides).	11·35	24·63	64·02

Hæmoglobin.—It is of great interest to note the marked increase of hæmoglobin, in the blood of the horse and mules, during the latent period of Surra, as it occurred in all the equines examined; but this increase was not observed in guinea pigs. The rise in hæmoglobin was always co-existent with a considerable increase in the number of red corpuscles.

When once the disease declared itself, there was a gradual diminution in the number of red corpuscles during the paroxysms and intermissions, and a corresponding fall in the percentage of the colouring matter of the blood, thus accounting for the progressive pallor of the visible mucous membranes, which is so marked a symptom of this disease. *Vide* Tables XVII, XXIII, XXX, XXXVII-VIII.

BOMBAY : PRINTED AT THE GOVERNMENT CENTRAL PRESS.

Address—MUKTESAR,
Naini-Tal District,
N. W. P.

No. 144 OF 1897.

FROM

ALFRED LINGARD, M.B., M.S., D.P.H.,
PROFESSOR OF COMPARATIVE PATHOLOGY
AND BACTERIOLOGY, C. V. D., INDIA.

To

THE INSPECTOR GENERAL,
CIVIL VETERINARY DEPARTMENT,
SIMLA.

Dated the 31st August 1897.

SIR,

I have the honour to forward my Annual Report for the year 1896-97 in accordance with the instructions from the Government of India, Revenue and Agriculture, conveyed in their letter No. 3151-36, dated 6th November 1893, communicated under your office letter No. 2090 M., of the 14th idem.

I have the honour to be,

Sir,

Your most obedient Servant,

A. LINGARD.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE OFFICIAL YEAR

1896-97.

CONTENTS.

REPORT	Pages
APPENDIX I—	
Journal for 1896-97	
APPENDIX II—	
Outbreaks of Surra during recent years—	
(*a*) In districts of the Punjab	8—1
(*b*) Do. do. North-Western Provinces	10—1
(*c*) Do. do. Central Provinces	1
(*d*) Do. do. Bombay Presidency	*ib*
Notes on Surra in Burmah, together with a case of the same disease in a private stable in Rangoon by Veterinary Captain G. H. Evans . . .	12—2
Plan of buildings, etc.	2
APPENDIX III—	
(A) (*i*) A short précis concerning the symptoms, etc., observed in bovines during the phases of Surra	2
(*ii*) Ditto concerning Surra in buffaloes	*ib*
(*iii*) Table showing the number of Paroxysms and Intermissions which occurred in the course of each case, together with their duration and other details connected with the cases	27—30
(*iv*) Physiological and Pathological problems *re* bovines and buffaloes, during periods of observation and the phases of surra	31
Untreated cases of surra.	
BULL V—	
(*a*) Table showing the weight of animal, grass eaten, water drunk, and dung passed during a preliminary period of observation and the phases of Surra	32
(*b*) Table showing the weight of animal, etc., during the massed periods .	33
(*c*) Table showing the quantity of the constituents of the urine . . .	*ib.*
(*d*) Ditto ditto during the massed periods . . .	*ib.*
(*e*) Table showing the mean daily quantity of the constituents of the urine .	34
(*f*) Ditto ditto in the massed periods	*ib.*
(*g*) Mean daily averages, with percentages and ratios, together with the water drunk and dung passed. *Table*	35
(*h*) Nitrogen ingested and egested. *Table*	36
(*i*) Ditto ditto in the massed periods	*ib.*
(*j*) Mean daily amount of Nitrogen ingested and egested. *Table* . .	*ib.*
(*k*) Ditto ditto in the massed periods	37

Pages

(*l*) Total loss by Nitrogen, CO_2, moisture, etc. 37
(*m*) Water ingested and egested, and the percentage excreted in urine and dung. *Table* . . . . . *ib.*
(*n*) Water excreted as urine, in the dung and by the lungs and skin. *Table* 38
(*o*) Table of percentage of dry matter digested . . . . . *ib.*
(*p*) Ditto ditto in the massed periods . . . . . *ib.*
(*q*) Quantity of dry food digested during whole period . . . . *ib.*
(*r*) Blood. *Table*—
(*i*) Number and ratios of corpuscular constituents with the number of hæmatozoa present in the paroxysms 39
(*ii*) Ditto ditto mean daily number for the massed periods . . *ib.*
(*iii*) Percentage of corpuscles in massed periods . . . . . *ib.*
(*s*) Statement of corpuscular changes in blood 40

BUFFALO No. I—
(*a*) Table showing the weight of animal, grass eaten, water drunk and dung passed during a preliminary period of observation and the phases of Surra 42
(*b*) Ditto ditto during the massed periods . . . *ib.*
(*c*) Table showing the quantity of the constituents of the urine . . . 43
(*d*) Ditto ditto during the massed periods . . . . . *ib.*
(*e*) Table showing the mean daily quantity of the constituents of the urine 44
(*f*) Ditto ditto in the massed periods . . . . . *ib.*
(*g*) Mean daily averages, with percentages and ratios, together with the water drunk and dung passed. *Table* . . . . . 45—46
(*h*) Nitrogen ingested and egested. *Table* 46
(*i*) Ditto ditto in the massed periods 47
(*j*) Mean daily amount of Nitrogen ingested and egested. *Table* . . *ib.*
(*k*) Ditto ditto in the massed periods 48
(*l*) Total loss by Nitrogen, CO_2, moisture, etc. . . . . *ib.*
(*m*) Water ingested and egested, and the percentage excreted in urine and dung. *Table* . . . . . 48—49
(*n*) Water excreted as urine, in the dung and by the lungs and skin. *Table* . 50
(*o*) Table of percentage of dry matter digested . . . . . *ib.*
(*p*) Ditto ditto in the massed periods 51
(*q*) Quantity of dry food digested during whole period . . . . *ib.*
(*r*) Blood *Table*—
(*i*) Number and ratios of corpuscular constituents with the number of hæmatozoa present in the paroxysms . . . . . *ib.*
(*ii*) Ditto ditto mean daily number for the massed periods . . 52
(*iii*) Percentage of corpuscles in the massed periods . . . . *ib.*
(*s*) Statement of corpuscular changes in blood . . . . . 52—53

BUFFALO No. II—
(*a*) Table showing the weight of animal, grass eaten, water drunk and dung passed during a preliminary period of observation and the phases of Surra 54
(*b*) Ditto ditto during the massed periods 55
(*c*) Table showing the quantity of the constituents of the urine . . . *ib.*
(*d*) Ditto ditto during the massed periods . . . . . *ib.*
(*e*) Table showing the mean daily quantity of the constituents of the urine . 56
(*f*) Ditto ditto in the massed periods . . . . . *ib.*
(*g*) Mean daily averages, with percentages and ratios, together with the water drunk and dung passed. *Table* 57
(*h*) Nitrogen ingested and egested. *Table* 58
(*i*) Ditto ditto in the massed periods . . . . . *ib.*

	Pages
(*j*) Mean daily amount of Nitrogen ingested and egested. *Table* . .	59
(*k*) Ditto ditto in the massed periods	*ib.*
(*l*) Total loss by Nitrogen, CO_2, moisture, etc.	60
(*m*) Water ingested and egested, and the percentage excreted in urine and dung. *Table*	*ib.*
(*n*) Water excreted as urine, in the dung and by the lungs and skin. *Table* .	61
(*o*) Table of percentage of dry matter digested	*ib.*
(*p*) Ditto ditto in the massed periods	62
(*q*) Quantity of dry food digested during whole period	*ib.*
(*r*) Blood. *Table*—	
(*i*) Number and ratios of corpuscular constituents with the number of hæmatozoa present in the paroxysms	62
(*ii*) Ditto ditto mean daily number for the massed periods .	63
(*iii*) Percentage of corpuscles in massed periods	*ib.*
(*s*) Statement of corpuscular changes in blood	*ib.*
(*v*) Remarks comparing the results obtained in the cases of Buffaloes I and II	63—65
(*vi*) Table showing the chief facts connected with the above mentioned animals, during the different periods of observation and disease (Surra) massed together	66
(*vii*) Summary of corpuscular changes in the blood of bovines and buffaloes	67—68
(*viii*) Notes concerning Surra in Bovines and Buffaloes	69
(B) Investigations—	
(*a*) During the hot season	69—74
(*b*) „ „ rains	74
(*i*) With regard to the presence or absence of the *Trypanosoma Evansi* in the blood of equines, the body fluids of fish, flies and ixodes, together with the results of the microscopical examination of water, obtained from Surra localities	*ib.*
(*ii*) With regard to the presence of the embryos of the *Filaria papillosa* in equines and bovines	75
Classification of certain species of flies caught upon the bodies of animals, the subjects of Surra	*ib.*

GOVERNMENT OF INDIA.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE OFFICIAL YEAR

1896-97.

THE Laboratory is not yet complete, work with regard to the installation of gas is proceeding, but the small house to contain the sterilizing apparatus and the cinerator have not yet been commenced.

As has already been reported to Government, great difficulty is experienced in obtaining fodder at Muktesar, owing to the small amount of cultivation in the hills. The harvest only supplying the wants of the inhabitants for a portion of the year. The neighbourhood of the Laboratory is sparsely populated and the services of agriculturists are difficult to obtain, owing to the fact that each family has a certain amount of land belonging to them, and this they cultivate during the months of June to September, inclusive, to supply millet, etc., for their own requirements. At the commencement of October, the inhabitants leave the hills with their cattle and proceed to their holdings in the Bhabar and Terai, where they remain until the following year. In consequence of the anxiety caused last year owing to the absence of fodder, during which period (four months) our animals subsisted principally on oak leaves, I represented this to Government, and after making careful enquiries, as to the best means of procuring supplies of grass, etc., for our ponies and cattle, submitted a method which would admit of work being carried on at the Laboratory. This scheme, however, did not meet with approval. Consequently, in September, I employed a number of coolies to cut as much grass as possible and stacked it for use during the winter. Coolies are obtained here with great difficulty, and the amount of grass cut and stacked was small, costly and quite insufficient to tide our requirements over the hot season, the period when it is impossible to obtain further supplies. A further representation will be made on this subject, as it is quite impossible for work to be carried on, if the wherewithal to feed animals be not forthcoming.

In continuation of my investigations commenced in 1891, with a view to determine whether the Surra parasite is ever present in the body fluids of flies, ticks, etc., other than when caught upon the bodies of diseased animals, I determined during 1896 to visit the localities known to be Surra centres within reasonable distance of the Laboratory, *viz.*, Kathgodam-Naini Tal Dâk line, Saharanpur-Mussoorie Dâk line, and Karnal—

(*i*) During the hot season of the year, when no cases of Surra exist.

(*ii*) During the rains, just before the disease usually manifests itself in equines.

Information having been received from Veterinary Lieutenant Loughlin on 15th May 1896, to the effect that cases of Surra had been reported amongst

the horses of the Saharanpur-Mussoorie Dâk line, at which period of the year the disease does not exist as a general rule in that part of India, I proceeded to visit the line with a view to determining the accuracy of the diagnosis. I visited all the stations in the Mohand Pass, where the disease had been reported to exist. A careful microscopical examination of the blood of the whole of the horses and mules, some 150 in number, was made, with the result that no case of Surra could be detected. At the same time I took the opportunity of examining stagnant and other water and the body fluids of various horse flies, ticks and fish, with a view to ascertaining whether the "Trypanosomæ" existed in them. In every case, however, negative results were registered. In addition, observations were made with regard to the presence of the *Filaria papillosa* (*equi*) in the circulation of equines examined for the Surra parasite.

On my return from Mohand, similar investigations were conducted in and around Saharanpur as well as within the Government Remount Depôt, with the same end in view, and with negative results.

Proceeding thence to Karnal (Punjab) on 8th June, an extensive series of observations were conducted, which included the examination of samples of water from every available source, in addition to the blood of samples of the contained fish and numerous specimens comprising some eight different species of flies and ticks.

The blood of thirty Government bullocks was submitted to microscopical examination to determine the presence or absence of the Surra *Trypanosoma* and the embryos of the *Filaria papillosa*. During my stay at Karnal, an opportunity offered itself, which allowed of my observing the symptoms and course of the disease in a horse attacked with *paraplegia*, etc., and subsequently of making an autopsy on the animal. The results of my inquiries during this tour are given in the report.

In accordance with my previously arranged plan to make a second series of observations during the rains, and just before Surra usually manifests itself in equines, I visited Saharanpur on 7th September, but the results of my investigations proved negative. From thence I proceeded to the Mohand Pass. The blood of some 130 horses and mules were here submitted to examination, with the result that the Surra hæmatozoon was discovered in the circulation of only two animals, which were in fine condition and stabled at an elevation of 3,000 feet. These horses belonged to a European firm.

On my return to Saharanpur, I was informed that many cattle were dying of rinderpest at and around the village of Sultanpur, some eleven miles away. Consequently, I proceeded there and was able to make several *post mortem* examinations and obtain pathological material for subsequent examination at the Laboratory.

On 14th September, I proceeded to Karnal and then proceeded to repeat similar investigations to those carried on during my previous visit in May. During my sojourn in Karnal, information was brought in that several horses were ill and losing flesh at the village of Tikri, where several Government and Municipal stallions are kept. On proceeding thither, microscopical examination proved the presence of the Surra organisms in the blood of a mare belonging to the "Lambardar" in charge of the sires. Notice of the above was immediately sent to the Inspector-General, Civil Veterinary Department, and the necessary steps taken for the removal of the horses.

On leaving Karnal, I received instructions to proceed to Simla, and, as privilege leave was due to me, the Government of India requested that I should at once proceed to England and there assist the Secretary of State for India in his selection of an Assistant Bacteriologist. After making a careful enquiry and interviewing various gentlemen, I submitted the name of Doctor J. W. W. Stephens as the gentleman most fitted for the post, and his services were accepted. The Secretary of State further sanctioned the deputation of this officer to visit the Chief Laboratories of Europe during a period of 60 to 70 days, with a view to making himself conversant with the methods, etc., employed by the principal Bacteriological *savants* of Europe, previous to his departure for Bombay, India, where he was ordered to report himself at the

commencement of the ensuing official year, April 1897. I regret to say that Dr. Stephens did not, however, avail himself of the opportunity offered.

On my return to Bombay, 30th January 1897, your office letter No. 97C., dated 28th January 1897, was handed to me, whereupon I left for the Laboratory, Muktesar, and arrived on the evening of 5th February. Here your telegram, dated 1st February, awaited my arrival, informing me of an outbreak of disease among the Army Siege Train and Army Transport Bullocks at Quetta, further I was requested to place myself in communication with Veterinary Captain H. M. Maxwell, Superintendent, Civil Veterinary Department, Baluchistan. In consequence of the information received from this officer I left the Laboratory on Sunday, 6th February, and proceeded to Quetta, arriving on the evening of 11th February. There I learned that thirty-one bullocks had succumbed during December 1896, and January 1897, and that eight had recovered, while three had died and six recovered amongst a draft of animals sent to Sibi from Quetta. Unfortunately, during a sojourn of eight days at the former station, only one animal succumbed, but I was fortunate in being able to examine the organs of several animals which had been preserved for inspection. The conclusion I arrived at as to the cause of the mortality was that the animals whose power of resistance to disease had been previously weakened by nutritive changes, etc., partially owing to the presence of large numbers of hydatid cysts in their organs, had fallen ready victims to pneumonia and pleurisy during the prolonged period of severe weather. A report embodying recommendations for future guidance was submitted to the Government of India for the information of the Military Department.

On the return journey to Muktesar in accordance with Government of India instructions, No. 97C., paragraph 3, dated 28th January 1897, I proceeded to Agra to inspect the Laboratory and grounds of the Chemical Analyst and Bacteriologist to the North-Western Provinces and Oudh, with a view to determine whether rinderpest investigations could be satisfactorily carried on there during the winter months of each year. A report embodying my views, No. 264, dated 12th March 1897, was submitted to Government on my return to head-quarters.

During the past seven months, 21 tubes of Mallein have been distributed to the officers of the Civil Veterinary Department and Army Veterinary School, Poona—

Lahore 7, Bengal 6, Central Provinces 6, and Poona 2 tubes.

Mr. M. K. Bamber, Clinical Assistant to the Imperial Bacteriologist, proceeded on privilege leave on 29th April 1896. At the beginning of August he resigned his appointment, but, at the request of the Government of India, continued his duties until 25th March 1897, during which interval he assumed charge of the office of the Imperial Bacteriologist, during my absence on leave in Europe, from 17th October 1896 to 30th January 1897. It was with regret that I heard of his intention to return to England, and my best thanks are due to him for the good work he has accomplished, especially chemical, during the four years he has been connected with the Laboratory, whilst at Poona and since its transference to Muktesar.

Herewith are enclosed three appendices—

(*i*) Journal of journeys undertaken during 1896-97.
(*ii*) Précis of the recorded outbreaks of Surra during 1896-97.

I wish to draw attention to the reports on Surra in Burmah, forwarded to me by Veterinary Captain G. H. Evans, Superintendent, Civil Veterinary Department, Rangoon. This officer has spent a considerable portion of his spare time in obtaining information with regard to the chief pathological changes found in equines, the subjects of Surra in his province, and in the microscopical examination of the body fluids of flies, with a view to determine whether the *Trypanosoma Evansi* could be discovered in *Diptera* caught in the jungle.

(*iii*)—(A) Containing a short statement of the results of physiological and pathological observations with regard to bovines and buffaloes, etc., during

a period of observation and the phases of Surra. The object in view as in equines was to elucidate the changes which take place in the blood of animals previous to and after contracting Surra, together with an inquiry into the ingested and egested nitrogen and water, for the purpose of explaining the rapid waste of tissue in this disease.

(B) Investigations—

(*a*) during the hot season,

(*b*) during the rains,

(*i*) with regard to the presence or absence of the *Trypanosoma Evansi* in the blood of equines, the body fluids of fish, flies and ixodes, together with the results of the microscopical examination of water obtained from Surra localities;

(*ii*) with regard to the presence of the embryos of the *Filaria papillosa* in equines and bovines.

Classification of certain species of flies caught upon the bodies of animals, the subjects of Surra.

APPENDIX I.

APPENDIX I.

JOURNAL OF JOURNEYS DURING 1896-97.

Surra investigations at the end of the hot season.

1896 .	May 28 . . .	Left Muktesar for Mohand.
	June 3 and 4 . .	Halt at Mohand.
	„ 6 and 7 . .	Rajpur (Dehra) and back to Mohand.
	„ 9 . . .	Saharanpur to Karnal.
	„ 19 to 22 . .	Karnal to Muktesar.

Surra investigations at the end of rainy season.

	September 3 . .	Left Muktesar for Mohand.
	„ 5 . .	Halt at Kathgodam.
	„ 10 to 13 .	Saharanpur.
	„ 14 . .	Saharanpur to Karnal.
	„ 15 to 20 .	Halt at Karnal.
	„ 20 and 21 .	Karnal to Simla.
	„ 22 to 29 . .	Halt at Simla.
	„ 30 to October 4	Simla to Muktesar.
	October 11 to 16 . .	Muktesar to Bombay and to England.
1897 .	January 31 to February 5.	Bombay to Muktesar.

Investigation into the cause of mortality in Government Army Transport and Siege Train Bullocks.

	February 7 to 11 . .	Muktesar to Quetta.
	„ 12 to 20 . .	Halt at Quetta.
	„ 21 . .	Quetta to Sibi.
	„ 22 to 25 .	Sibi to Agra.
	„ 26 to 28 .	Agra to Muktesar.

During the official year 1896-97, 8 months and 18 days were spent in India. I travelled 6,460 miles by rail and 536 miles by road.

APPENDIX II.

OUTBREAKS OF SURRA DURING RECENT YEARS.

APPENDIX H.

PUNJAB.

Peshawar District.

Peshawar Tehsil.—Surra made its appearance in two low-lying villages—Garhi Sardar and Wadega—during the months of September and October 1895. The loss was three horses or 16 per cent. of the animals possessed by the inhabitants of the two villages.

Jhelum District.

Pind Dadan Khan Tehsil.—In four low-lying villages, *viz.*, Meri Osman, Kullan, Jetipur, five animals succumbed to the disease during the months of May, July, August and December 1896. The vernacular name is "Sokra."

Mooltan District.

Lodhrian Tehsil.—During the months of April, May, and June 1895, Surra, vernacular name "Sar," is said to have broken out amongst the equines of the villages of Jelalabad, Baspar, Motha and Bahadarpur, when 24 horses out of a total 37 succumbed to the disease, representing 64 per cent. possessed by the villagers.

Gujranwala District.

Gujranwala Tehsil.—Reports have been received concerning the outbreak of Surra in equines during 1894, from nine low-lying villages, *viz.*, Dhodhiwal, Adorai, Kotlidaba, Tharanwala, Tamoli, Kotkhas, Akbar, Cahmanwala and Canour. The loss comprised 23 horses and 21 asses. These succumbed during the months of August—November.

Wazirabad Tehsil.—During October and November 1892, the village of Kakakolu lost 5 horses and 10 asses. In the year following, during the months of October and November, in the village of Janki-Chatta in the same tehsil, 3 horses and 5 asses succumbed to Surra, vernacular names "Phenta," "Sokra," neither of these were low-lying.

During 1893-95, Chaksada, a low-lying village, lost several horses and mules equivalent o 45 per cent. of animals possessed. Surra called "Pheta."

Khangah Tehsil.—One low-lying village, Manga, lost two asses only in October and November 1895. Disease called "Pheta."

During the year 1896, nine low-lying villages suffered loss from Surra:—they included Jandiala Sarchkhan, Madialadarkan, Shahpur, Jhabbar, Tarhoon, Shaikhupura, Jhamkee, Dharmpura, Anikee. One animal died in March, but all the others succumbed during August, September and October. Disease called "Phenta."

Lahore District.

Lahore Tehsil.—Three low-lying villages, Chakwonti, Keela-Jewan Sing and Bhatni suffered a loss during the months of December 1894, January 1895, of 24 horses and 22 asses.

Chunian Tehsil.—A village of this tehsil, Tarda, low-lying, lost 12 horses in March 1895 from Sokra.

Veterinary Captain Pease informs me that Surra is by no means uncommon in the Lahore District along the low-lying portions of land bordering the rivers Ravi and Daeg, where it is known as "Zahrbad." All the limbs swell and the usual symptoms are present. Five cases were taken for treatment to the veterinary college during the "Surra" season.

Ferozepur District.

Twenty villages are recorded as having been the seats of Surra outbreaks during the years 1890-96; the loss sustained was 155 horses, 113 asses and 1 mule, which were distributed amongst the three tehsils as follows:—

Ferozepur Tehsil.—The 17 villages (Bagguwala, Dulasingwala, Kurrian Khoord, Suba, Jalalwala, Attari, Katora, Wahki, Palla Megha, Kamelaewala, Dulchiki, Gulam Hussainwala' Yareshahwala, Bhala, Saidushahwala, Chungali Kadeem, Chungali Jadid) affected with Surra during the years 1893-96, vernacular names being, "Andar Táp," "Táp," "Sokra," "Phenta," "Marri" "Soka," "Tape-dik," were mostly low-lying.

Fazilka Tehsil.—Ladhuka and Hasta, low-lying villages, lost a few animals from this disease "Sara" during May 1890.

Muktsar Tehsil.—One outbreak at "Mokamarain" continued according to the report submitted during the months May to August 1895. Eight horses succumbed to the disease "Phenta."

Gurdaspur District.

In the two tehsils "Pathankote" and "Shikargarh," Surra appeared during 1896-97, but the losses recorded were very small. The names of the villages were Dhaki and Kulla, respectively.

Amritsar District.

Ajnala Tehsil.—Three villages in this tehsil, *viz.*, Chandan, Sangatpur and Thanjhor suffered very heavy losses from Surra during the months August-November 1894. The actual number which succumbed were 62 horses, 34 asses and 1 mule; equal to 92 per cent. horses, 40 per cent. asses and 100 per cent. mules possessed by the villagers.

Hoshiarpur District.

Surra, vernacular name "Wabai ki-bukhar," is reported to have occurred in three (Garshankar, Todarpur and Bhanniwal Gujran) villages in this district. The cases occurred in 1894-95, and the position of the affected villages is described as low-lying and subject to flooding.

Out of 74 horses and 50 asses, 61 and 32 animals, equal to 82 per cent. and 64 per cent., respectively, succumbed to the disease.

Ludhiana District.

Jagraon Tehsil.—In 1895 and 1896, Surra outbreaks occurred in fifteen villages in the above tehsil, *viz.*, Gursian Makhan, Bhoondri, Alliwal, Ghumnawal, Walipur Kalan, Walipur Khurd, Rangi, Jamba, Gora, Tilwara, Tilwandi, Bheruwal, Man, Pabiyan and Malik. These villages are situated in a very unhealthy portion of the district, low-lying and alluvial subject to inundation from the river Sutlej and the Badha Nála.

In these fifteen villages, out of 104 horses, 38 or 36 per cent. died, whilst only 14 asses or 11 per cent. out of 122 succumbed. The vernacular name given to this disease in equines is "Pheta."

In the village of "Man" during the month of July 1895, 42 camels out of a total of 50 died from this disease known in this part of the country as "Purana."

Again, during 1896, Surra broke out in the month of September, in the village of "Bheruwal" and carried off several camels. At a later date information was received notifying a still greater loss from the same cause.

Umballa District.

Jagadheri Tehsil.—Surra made its appearance in October 1894 in the low-lying village of Aurangabad, and out of 17 asses, 13 or 76 per cent. were lost, although some horses were owned by the villagers, none succumbed to the disease. In the following year the animals in the village of "Galni," also subject to inundation, were attacked, 80 per cent. of the horses, cent. percent. of the asses and mules died from this malady.

Umballa Tehsil.—In the Dhin *gaon*, said to be free from inundation, the disease broke out in the months of November and December 1895, and carried off 25 or 20 per cent. of the asses owned.

Pipli Tehsil.—This portion of the district, which is swampy and subject to inundation during the rainy season, is a well-known centre of Surra. Surra broke out in the village of Radour in November 1895, but the losses were not heavy; again in 1896 "Chibha" suffered somewhat from the same disease.

Vernacular names of disease "Pheuta," "Phera."

Karnal District.

In our last Annual Report, 1895-96, Karnal District was shown to be the most deadly locality for equines in the Punjab. For in over 200 villages nearly half of all the animals kept, succumbed to Surra. During the season 1896-97, the rainfall was considerably under the normal quantity, consequently the outbreaks of this disease are very few in comparison with those recorded after a wet monsoon.

The following cases have been reported for 1895-96, in addition to those already published.

Kaithal Tehsil.—In seven villages, *viz.*, Rasina, Paikan, Dhola, Bhateri, Meoli, Koal and Bhona, nine horses and seventy-one asses succumbed.

Karnal Tehsil.—During July, August and September 1895, three villages, *viz*, Sangat, Ranipur and Gowalior, lost 24 horses, 20 asses and 15 mules out of 54, 47, 25 horses, asses and mules, respectively.

Panipat Tehsil.—During the rainy season of 1894-95, four villages, *viz.*, Raka Heda, Assan Kalan, Somela Malana and Pasina Kalan, lost 28 horses.

In 1896-97 three villages, *viz.*, Amin, Balo and Lekri, lost 1 horses.

When visiting Karnal in September 1896, I, by request, proceeded to Tikri, a village some four miles from the Government Depôt, where several stallions belonging to the Government

and the District Board were stationed, and found the Surra hæmatozoon present in the blood, on microscopial examination, of two mares belonging to the villagers.

Delhi District.

Soneput Tehsil.—Reports submitted with regard to the outbreaks of Surra during recent years, *viz.*, 1892-96, in seventeen villages situated in this tehsil, *viz.*, Jalai, Thaira Ulaipur, Jojub, Jorai, Ganowar, Bari, Datoli, Ghalobi, Pelikhera, Behra, Manauli, Haterna, Jakhawli, Khewrab, Mailsena, Gona and Mohana.

The loss sustained was slight, in comparison to those in the bordering district of Karnal, only 48 horses, 38 mules, and 8 asses succumbed.

The above Surra returns are abstracted from the reports sent in from time to time by Veterinary Captain W. D. Gunn, Assistant to the Inspector General, Civil Veterinary Department.

NORTH-WEST PROVINCES.

Muzaffarnagar District.

Only incomplete reports have been received with regard to the outbreak of Surra which appeared in 1896-97 in three villages in this district, *viz.*, Sahjerao, Cherthawal and Kachauli. A few animals only succumbed during the last season, owing to the scarcity of rain; but many outbreaks were recorded during 1895.

Naini Tal District.

Kathgodam.—In accordance with a request received on August 31st, 1896, from the Agent of the Rohilkhand and Kumaon Railway—that I would examine and give an opinion as to the cause of an outbreak or a malignant type of fever, from which the horses of the Kathgodam-Naini Tal Tonga service were suffering—I reported as follows:—

High temperature, with the ordinary signs of fever, rapid loss of flesh and consequent weakness, great pallor of the visible mucous membranes, and in most cases complete loss of appetite, at all events during the presence of fever.

On September 4th, 5-15 P. M.—I examined microscopically the blood of six Tonga horses stationed at Kathgodam, which had been the subjects of fever for varying periods. In the blood of four of these animals the Surra hæmatozoon was demonstrated.

September 5th, 6-30 A. M.—In company with Mr. James (Traffic Manager) and Mr. E. Brady (Tonga Superintendent), I visited the different stables between Kathgodam and the Brewery, the blood of all horses which had shown any symptoms of fever was submitted to microscopical examination with the following results:—

Name of Stables.	No. of animals.	Surra Hæmatozoon in blood.	Hæmatozoon absent.
Bhugiaghat . . .	6	4	2
Amparao . . .	11	10	1
Brewery . . .	2	2	0
	19	16	3

At 5-30 P. M.—On my return from the Brewery, the blood of fourteen horses at Kathgodam was subjected to examination, including that of six animals previously examined (4th September). On this occasion the Surra hæmatozoon was discovered in five, leaving nine doubtful cases.

September 6th, 7 A. M.—The blood of the above nine doubtful cases was re-examined with the result that the hæmatozoon was found present in the circulation of three of these animals, reducing the number to six; but as other symptoms pointing to the presence of Surra in the remaining number of animals were more or less marked in all, there is no reason to doubt that all the horses above mentioned will eventually succumb to that disease.

A *post mortem* examination on one of the animals revealed the usual pathological changes found in Surra cases.

Number of horses which succumbed to fever between the 1st July and 4th September, 1896	32
Number of horses in whose blood the Surra hæmatozoon was demonstrated microscopically.	24
Horses which presented signs of Surra	9
Number up to A. M., 6th September, 1896	65
Already succumbed or the subjects of Surra	65
Animals which succumbed to Surra before the end of October 1896	27
Number of horses commenced season with	92

Since 1892, when a fresh supply of water was brought to Kathgodam from the Hills, everything possible has been done by the Superintendent of the Tonga service to protect the horses under his care from Surra. The water was subjected to boiling before the animals were allowed to drink it. The grass instead of being obtained from the plains has for years been collected during the cold season of the year (November, December and January) from the highlands at an altitude of 4,500 feet; all gram and corn has been carefully cleaned and screened since 1894, in order to avoid the presence of rat excrement, and the creeper (Bel) has not been utilized during the past year as fodder, as is the case in the Simla Dâk service.

After eliminating the above sources of the contagium of Surra, only two (as far as we know) are left for consideration :—

(*i*) If one animal contracts the disease through the disobedience and stupidity of its syce, *i.e.*, by allowing the animal under his charge to graze or drink by the wayside, on the return journey to its Chowki—the disease once started may be spread by the inoculation of flies.

(*ii*) Flies might perhaps take into their systems the Surra protozoon or its spore form, when drinking the water of ponds or brooks and directly communicate the disease to the animal they bite? But it is more likely that the flies obtain the hæmatozoon from a previous case of Surra, either in equines or other animals.

Since 1891, I have been examining the body fluids of flies for "Trypanosoma," during the two months preceding the one (September) in which Surra usually appears in epidemic form in animals; but up to the present time without success, although on numerous occasions one has demonstrated a different variety of hæmatozoon swarming in the blood of different kinds of fish. Until one is successful in obtaining more definite information as to the means by which the animals contract Surra, nothing that I can suggest will prove of any avail in combating the disease. In previous reports to Government, it has been pointed out that only animals in good condition are suitable to undergo treatment for Surra. It will be found impracticable to attempt to cure ill-preserved animals, such as Tonga ponies, towards the end of a heavy and hard worked season.

In no other Tonga service in India with which I am acquainted, do the animals receive the same amount of supervision, care and attention as those under the Superintendent of the Rohilkand and Kumaon Railway Tonga service, Kathgodam.

In addition to the animals which succumbed to Surra belonging to the Rohilkand and Kumaon Railway Tonga service, private owners of ekka and riding ponies lost some eighteen animals from the same disease at and around Kathgodam.

Central Provinces.

Jabbalpur.—Veterinary Lieutenant R. L. Crawford, A. V. D., in March 1897, reported on an outbreak of Surra at Jabbalpur among the police horses stationed there.

The first animal to show signs of the disease was brought from Nagpur on 5th September and died 18th October 1896. Twenty-three horses in all succumbed to Surra up to 17th February 1897. Two of the above animals were brought from the Native Cavalry Regiment quartered in Jabbalpur, but no case of Surra occurred amongst the horses of this regiment during the previous year or during the time the outbreak of the disease was present in the police lines.

All the animals which succumbed presented the usual symptoms of Surra.

Excessive rain fell during the wet season of 1896.

None of the horses improved when treated with Liq. Arsenicalis, but this was ascribed to the low condition they were in, previous to the treatment being commenced. Veterinary Lieutenant Crawford points out that the last two animals did not improve on arsenic, but stood the disease longer than any of the previous ones in spite of their condition.

Bombay Presidency.

Bombay—The Tramway Company's losses during the Surra season 1896-97 amounted to 20 horses. Of these fourteen were Australians varying in age from 5 to 16 years, the remaining 6 were country-breds varying from six to twelve years. It will be observed on looking at the chart of cases that 18 of the 20 animals affected with disease were seized during the usual period of the year—1 in August, 7 in September, 7 in October, 2 in November and 1 in the following January. One case was diagnosed in February 1896, and this, of course, belonged to the previous season. The other contracted Surra during a most unusual month, *viz.*, 9th May 1896. On reference to our records,* published 1895, we find that out of 620 cases of this disease only one occurred during the month of May, and that animal was stationed a few miles out of Bombay.

* Report of outbreak of Surra and Filariasis at Kurnal Depôt—Appendix H.

TABLE I.

Showing the number of horses affected with "Surra" from February 1896 to 19th May 1897.

Horse No.	Date of purchase.		Color.	Breed.	Sex.	Age.	Date when taken in Hospital.	Date when Surra found.	Remarks.
39	February .	1891	Bay	Aust	Geld.	10	30-12-95	2-2-96	Destroyed.
267	October .	„	Grey	„	„	12	17-4-96	9-5-96	...
59	January .	1890	Bay	C. B.	„	12	12-8-96	31-8-96	...
188	December .	1884	„	Aust.	„	16	24-8-96	1-9-96	...
806	November .	1892	„	C. B.	„	10	2-9-96	4-9-96	...
104	December .	1890	„	Aust.	Mare	11	15-9-96	16-9-96	...
574	February .	1896	„	„	Geld.	6	16-9-96	„	...
952	December .	1894	„	C. B.	„	8	„	„	...
1067	„ .	1895	„	„	„	7	15-9-96	„	...
986	February .	„	Dun	„	„	6	21-9-96	23-9-96	...
735	October .	1888	Chestnut	Aust.	„	16	11-9-96	8-10-96	...
238	December .	„	Roan	„	Mare	16	5-10-96	10-10-96	...
990	March .	1895	Grey	„	„	8	„	13-10-96	...
949	December .	1894	„	C. B.	Geld.	8	8-10-96	14-10-96	...
1094	February .	1896	Black	Aust.	„	5	31-7-96	16-10 96	...
45	„ .	1891	Bay	„	Mare	10	13-10-96	22-10-96	...
408	November .	„	Grey	„	„	11	„	„	...
519	May .	1892	Chestnut	„	Geld.	9	3-11-96	6-11-96	...
840	October .	1894	Bay	„	„	7	18-11-96	26-11-96	Died.
243	December .	1890	„	„	Mare	12	22-1-97	26- 1-97	Destroyed.

Notes on Surra in Burmah.

Communicated by Veterinary Captain G. H. Evans.

Outbreak amongst Military Police Ponies at Mandalay, July 1896.

A number of ponies, Mounted Infantry and Transport, of the Yamethin Battalion arrived at Mandalay from Yamethin on the 26th April 1896.

On the 1st of June a pony was found to be suffering from fever, and also showing suspicious symptoms of Surra; he was promptly segregated and treated with Arsenic. This animal died on the 23rd June. No microscopic examination of the blood was made. This pony had been to Zagobin and May-myo; he is supposed to have contracted the disease on the road.

Case 2.—This animal had been in poor condition for a long time, so was excused duty, received tonics including Arsenic, also an extra ration of grain. On the 1st June he was admitted suffering from fever. A few days later the case became very suspicious, so the animal was isolated. He died on the 29th June. There was no microscopic examination of the blood. A noteworthy fact about this case is, that the pony had not been out of Mandalay.

On the 20th July there were twelve cases of fever in the sick lines; an examination of the blood was made in all these cases, and two animals were found to be suffering from Surra. Both animals were destroyed.

On the 22nd June a Transport pony arrived from May-myo, showing suspicious symptoms, of Surra. The case was segregated; however, on the 7th July, the Commandant being satisfied that the case was Surra, had him destroyed. It is suspected that the disease was contracted on the May-myo road.

The ponies of the Battalion have not been allowed out to graze, the grass (Doob) is brought in by Burmans, and is always dried in the sun for at least one day before it is given to the animals. The allowance is thirty pounds for each pony. The grain ration is paddy, quality good; ration for Mounted Infantry five pounds, and for Transport animals four pounds per diem. Water appeared to be of excellent quality.

The buildings used as stables are long sheds with thatched roofs. The lines are kept in a sanitary condition.

There is a Police Post at May-myo, which is situated on the Shan plateau at an elevation of 3,600 feet, and is some forty miles distant from Mandalay.

The stages are Tonbo, Nyaungbaw, and Thondaung. *Tonbo* is at the foot of hills, the land is low-lying, *i.e.*, paddy fields, etc., etc. There is a good deal of bamboo jungle about. The Tonbo stream runs alongside of the road, but once the rains commence, pools of stagnant water are formed all over the place. The grass obtained here is rank.

Nyaungbaw is on the Zebingyi plateau. Water from a running stream; the grass is coarse.

Thondaung.—Good grass is procurable, but that growing on low-lying parts is most inferior. Water-supply from a running stream.

May-myo.—The grass excepting in the swamp and its vicinity is good. Water from wells and stream.

The Commandant informed me that all his ponies did well at May-myo. Thirty animals, very poor in condition, were sent there as an experiment, and every one of them picked up wonderfully. The ponies have been changed once a month. May-myo is certainly a bad place for Surra; if I remember rightly, a certain Mountain Battery came down from Bhamo as it was unhealthy for the mules and went to May-myo. The result of the change was anything but satisfactory, for they suffered heavy losses from this disease.

Mandalay.—On the 28th July I visited the lines and found that several ponies had been isolated owing to having abnormal temperatures. I determined, however, to examine specimens of the blood of all animals in the lines, the result being that I discovered thirteen cases of Surra; these were isolated. On the 30th, I examined all animals found fit on the 28th, and discovered two more cases. On the 1st August, I found a fresh case, and on the 5th, two more cases,—one from among the line ponies, the other out of a batch of animals that had arrived from May-myo the day previous. I destroyed sixteen of these cases, and placed the remaining two under treatment.

A party with twenty-three ponies left Mandalay on the 16th May and returned on the 21st; Nos. 12, 13, 14, and 15 were of this party.

Post-mortem Observations.

With regard to the *post-mortem* appearances of this disease in Burma, one lesion is rarely if ever absent, *viz.*, some change in the mucous membrane of the stomach, more especially of the cuticular coat, pigmentation, erosion, or ulceration. The positions in which these changes are most constantly met with are along the line of junction of the cuticular with the villous portion, and also at the lesser curvature. If an animal be destroyed during the early stages, discoloured muddy yellow patches may be observed; if examined closely, one or all of them may present an eroded appearance. These changes are in most cases no doubt due to thickening and proliferation of the epithelium which degenerates and breaks down, leaving the yellowish shallow ulcers; these, owing to progressive degenerative changes, become deeper, until in many cases, perforation occurs. The ulcers may cover an extensive surface. I have seen some six or seven cases in which from half to three-quarters of the cuticular coat was in an ulcerated state, and it was while making *post-mortems* with another officer of the Department, that we came on two of the cases referred to, and in which no less than three-quarters of the cuticular surface was involved. The animals from which these stomachs were taken were destroyed, as they were suffering from Surra; neither were in bad condition, and were taking food up to the very last moment. Though the cuticular coat is invariably involved, the lesions undoubtedly do in some cases extend to the villous portion, the anatomical difference, however, naturally to some extent, alter the appearances of the ulcers, which are often seen with a smoother flat surface, and surrounded by a ring of swollen mucous membrane.

I am of opinion that in all cases of death from chronic Surra, or in animals that have been destroyed after the disease has been in existence for some time, that ulceration of the stomach, more or less extensive, will be seen *post-mortem*.

The deep yellow pigmentation is not constant, but in nearly all cases there is a distinct yellowish tinge about the cuticular coat. The villous portion often is in parts owing to degenerative changes, denuded of its epithelial lining. In some cases a large portion of the cuticular coat may be pigmented. The color is a bright yellow, which shows up beautifully alongside of the whiteness of the normal epithelium. Parasites (*spiroptera microstoma*) are constantly found, specially in the stomachs of mules, embedded in the gelatinous mucous on the villous coat, but, as you are well aware, have nothing to do with the disease. Bots are frequently met with, and this year I met with a case where the bots had attached themselves to the mucous membrane of the duodenum; there were quite one hundred. Spiroptera nests are sometimes seen in the stomach, I think more frequently in mules, but they are rare. Last month I was present at forty-one *post-mortems*, but did not observe a single nest. I have heard it stated that feeding on unbruised paddy might cause gastric ulcerations; if this was the case, I am certain that I would have noticed it in *post-mortems* on animals that had not succumbed to Surra. In Lower Burma the people rarely give their animals anything else (Rangoon not included). I always feed my Burman ponies on paddy and never think of crushing it.

I have never observed ulceration of the small intestines, but have noticed circumscribed local congestions. In a few cases extensive mucous congestion was noted. The intestines often contain a quantity of a very yellow fluid. Nothing remarkable to note about conditions of the large intestines. In advanced cases the spleen is generally enlarged; there is as a rule an excess of pulp so that it pits on pressure. The structure is at times disorganized.

The liver is usually very healthy; cases of congestion, softening, may be met with; military calcareous deposits are often seen. In some cases the organ is much enlarged. I have noticed flukes in the livers of some cases.

Kidneys.—These organs are frequently affected, at times anæmic and œdematous, at others slightly or markedly congested. I have observed in some cases considerable blood extravasation on, and in the under parts of these organs.

The lymphatic glands are frequently found in an œdematous state.

The heart has gelatinous accumulations in its furrows, instead of fat. In chronic cases the organ is pale, flabby, very often enlarged, and very soft. The cavities are filled with blood or variegated clots, which extend into the great vessels. On several occasions I have seen the Aorta in an Atheromatous state. The heart constantly presents some abnormal condition, the more frequent being sub-endocardial ecchymoses, more or less extensive.

The lungs are, as a general rule, healthy, but cases in which they are congested are by no means infrequent.

I have examined the brain and cord carefully, but have never discovered much; in a few instances the brain substance was undoubtedly soft, and the Plexus choroides pale and bloodless. There is little to note about the bladder; in some cases a patch of extravasation may be observed at the Fundus, or small petechial spots scattered over the mucous membrane.

Carcases of animals that have died from this disease present a dreadfully emaciated appearance, only skin and bones. There is, as a general rule, an anæmic condition of all organs, and absence of fat. In some cases there is an excess of fluid in the abdominal and thoracic cavities, also in the pericardial sac. Rigor Mortis is normal.

Chin Hills.—The dangerous part of this road lies between Kalewa and No. 2 Stockade. At Kalewa the animals should only be watered from the river. Grass might easily be brought up by steamers from Mandalay or other station.

Natchigon.—Water from the Myit-tha River. Grass and straw should be stacked—Kalemyo.

Camp at Pyinthazeik.—Water from the river. Grass stacked.

No. 2 Stockade.—Water-supply from a mountain stream near camp; grass to be collected here. I think the waters of the rivers are safe enough.

Barnardmyo—The Terai between Tabeitkyin and Shwenyoungbin is very unhealthy. At Tabeitkyin the Transport should water up the Irrawaddy (all backwaters must be avoided). Grass is very bad; should be collected at Tabeitkyin, Wahpyudaung, Kyauklebin and Shwenyoungbin. After January only dry bamboo leaves and thatch grass are obtainable within easy reach of camp, so, after the first couple of storms, there is a rush for any green fodder.

Kengtung.—I do not know the road beyond Taung-gyi, about 130 miles from Meiktila. Transport should be watered at Hlinedet and Yemabin from good wells, at Pyinbung and Nampandet from the river, and at Wetpyuyet, Kalaw, Thamakhan, Heno, Bwethet from wells, as I think the ordinary waters are suspicious. Grass ought to be collected at Hlinedet, Yemabin, Pyinoung, Nampandet, Wetpyuyet, and Kalaw. Quantities of good grass can be obtained from Kalaw onwards.

TABLE II.

Showing certain details concerning the Ponies destroyed in Mandalay, on account of Surra together with the pathological changes found in the stomach, and the weight of the principal organs in each case.

No.	Description.	Height.	Age.	Condition.	Temperature °F.	Hæmatozoa.	Date of Destruction.	Stomach.	Heart.	Liver.	Spleen.	Kidneys.	Remarks.
			Years.						lbs. ozs	lbs. ozs.	lbs. ozs	ozs.	
1	Gelding . . .	12 2	8	Excellent	102·2	Swarming	1st August 1896	Slight ulceration of cuticular coat.	2 9	6 12	2 0	12 each.	No œdema and no urticaria.
2	Mare . . .	12 0	13	Poor	103·0	„	„	Ditto . . .	3 8	7 12	2 8	14 „	Miliary calcareous deposits throughout substance of liver. Petechiæ lying under the epicardium.
3	Gelding . . .	11 2	13	Fair	105·0	„	„	Marked ulceration . .	3 6	7 6	2 6	16 „	Few calcareous nodules in liver; heart hypertrophied with dilitation.
4	Grey Gelding . .	12 1	8	„	101·2	„	„	Ditto . . .	3 4	7 12	2 10	14 „	Peri-hepatitis and calcareous deposits throughout substance of liver and both lungs.
5	Bay Mare . .	11 2	11	Excellent	100·2	Few	„	Slight ulceration, pigmentation marked.	3 0	7 14	3 0	13 right. 14 left.	Extensive endocardial ecchymoses.
6	Chest. Gelding .	12 2	10	Fair	104·0	Swarming	„	Marked ulceration . .	3 4	6 4	2 0	14 „ 13 right.	Liver firm, but of a very pale brownish yellow color.
7	Bay Gelding . .	11 3	11	„	101·4	„	„	Ulceration moderate, walls thick.	3 8	8 12	3 8	14 each.	Œdema of sheath, liver and spleen enlarged, sub-capsular petechiæ of latter organ, sub-endocardial ecchymoses.
8	„ „ . .	12 2	10	Very good	100·4	Few	„	Ulceration well marked .	3 0	6 8	2 12	14 „	Old endocarditis with thickening of mitral valves.
9	Dun Gelding . .	11 0	8	Poor	101·0	„	3rd August 1896	Ulceration slight, eroded patches.	2 12	8 8	2 0	13 „	Calcareous deposits numerous throughout substance of liver and both lungs.
10	Grey Gelding . .	12 0	14	„	104·2	Swarming	1st August 1896	Ulceration free, pigmented and cuticular white patches.	3 9	7 14	2 14	14 „	Calcareous deposits numerous, lungs and liver; circumscribed collections of blood beneath capsule of spleen; sub-endocardial ecchymoses.
11	Chest. Mare . .	12 1	8	Fair	105·0	„	3rd August 1896	Extensive ulceration .	2 14	8 8	2 10	14 „	Sub endocardial ecchymoses; small extravasations of blood under epicardium.
12	Bay Gelding . .	11 3	5	„	105·0	„	„	Extensive ulceration pigmented patches.	3 8	9 6	3 12	14 „	Œdema of lungs and sheath; heart hypertrophied; old endocarditis; old pleuritic adhesions; large cicatrix on left lung.
13	Chest. Mare . .	12 1	7	Poor	104·2	„	„	Three-fourths cuticular coat ulcerated.	3 0	8 15	2 10	14 „	The stomach was in a terrible state, ulcers large, all but perforation. Sub-endocardial extravasation.
14	Bay Gelding . .	12 0	6	Good	104·0	„	„	Considerable ulceration .	3 2	8 0	2 3	15 „	One ulcer 1½ inches in diameter was surrounded by a broad band of yellow pigment.
15	Grey Gelding . .	12	8	Fair	103·2	„	„	Slight ulceration . .	3 4	6 11	2 10	13 „	Stomach discoloured; many eroded patches.
16	Black Gelding . .	12 0	11	„	100·4	Few	„	Ditto . . . Patches of erosion . .	2 10	9 10	2 8	12½ „	Spleen sub-capsular petechiæ; heart soft, flabby, and walls much thinned.

TABLE III.

Showing certain details concerning the Mules destroyed in Manddlay, on account of Surra, together with the pathological changes found in the stomach, and the weight of the principal organs in each case.

No.	Description.	Size.	Condition.	Date of admission.	Temperature °F.	Hæmatozoa.	Date of Destruction.	State of Stomach.	Lungs.	Heart.	Liver.	Spleen.	Kidneys.	Remarks.
										lbs. ozs.	lbs. ozs.	lbs. ozs.	lbs. ozs.	
422	Brown Gelding	Moderate	Fair	21st July 1896	105	Swarming.	28th July 1896	Extensive ulceration of cuticular coat.	Healthy	2 11	8 0	2 15	1 7	No œdema or urticaria.
22	Bay Mare	,,	,,	19th ,,	103	,,	,,	Extensive ulceration of cuticular portion.	Normal	2 12	8 12	2 8	1 1	Ditto ditto.
132	Brown Mare	,,	Very poor.	23rd ,,	101	Few	,,	Marked ulceration, almost perforation at one spot. No pigmentation.	,,	2 13	6 15	3 7	0 15	Spiroptera micros, many Bots in stomach and Duodenum.
880	Bay Gelding	Small	,,	19th ,,	101	Swarming.	,,	Marked ulceration, slightest pigmentation.	,,	2 9	8 0	2 6	0 13	Ditto. Parasites in intestines, *Liver* calcareous deposits. Atheroma of Aorta.
235	Dark Brown Mare	,,	Fat	21st ,,	102	,,	,,	One large ulcer ½" × ¼", many others smaller.	,,	2 10	8 12	3 4	1 8	Gelatinous accumulation in furrows. No œdema or urticaria. Kidneys much enlarged and congested.
1220	Bay Gelding	,,	Moderate	20th ,,	102	,,	,,	Ulceration slight	,,	2 2	7 10	2 4	0 10	Œdema of sheath. Old peri-hepatitis.
102	,,	Moderate	Fair	21st ,,	102	,,	,,	Ditto	,,	2 11	6 6	2 6	0 10	Slight œdema of limbs, no urticaria.
243	Dark Bay Gelding.	,,	Poor	18th ,,	102·4	Numerous	,,	Ulceration slight, circular patches on villous coat.	,,	3 0	7 6	2 4	0 12	Lachrymation, no œdema or urticaria.
1135	Brown Mare	,,	Very poor.	25th ,,	100·2	,,	,,	Slight ulceration at one point on to villous coat.	Diseased	3 0	6 8	1 12	1 3	Small abscesses in substance of left lung. Sub-endocardial ecchymoses.
814	Dark Brown Mare.	,,	,,	22nd ,,	102·2	Swarming.	,,	Extreme ulceration, mucous membrane, villous portion denuded in places	.....	3 0	6 0½	1 8	0 8	Lungs consolidated, interlobular deposition of jelly, like contagious Pleuro Pneumonia. Liver calcareous nodules.
G 300	,,	Very large.	Emaciated.	24th ,,	101·3	Few	,,	Ulcerated, pigment much erosion.	Healthy	4 9	10 8	3 10	1 4	Œdema of lungs.
348	Chest. Mare	Moderate	Very poor.	23rd ,,	101	Swarming.	,,	Marked ulceration, circular patches on villous coat.	,,	3 8	7 8	1 8	1 6	Spiroptera micros, also few Bots.
G 23-4	Bay Gelding	,,	,,	,, ,,	104	Numerous	,,	Extensive ulceration	,,	3 8	9 8	2 8	1 9	Lachrymation profuse, no œdema or urticaria. Atheroma of Aorta. Liver very hard; kidneys large, pale and soft.
185	Bay Mare	,,	Poor	25th ,,	102	Swarming.	,,	Extensive ulceration extending on to villous portion.	,,	3 7	7 12	3 0	1 4½	Spiroptera micros, and few Bots.
66	Chest. Gelding	Very small	,,	20th ,,	102	,,	,,	Extensive ulceration along border.	,,	2 7	6 0	1 8	0 12	Mucous membrane; villous portion denuded in parts.
83	Brown Mare	Small	,,	19th ,,	100·3	Few	,,	Ulceration present	,,	2 13	7 15	3 2	0 14	No œdema, no urticaria.
398	Brown Gelding	.....	Emaciated	21st ,,	101·3	Numerous.	,,	Slight ulceration cuticular coat	,,	2 9	8 15	3 0	1 0	Ditto ditto.
274	,,	.....	Fair	9th ,,	101·0	Few	5th August 1896	Slight ulceration, marked erosion, slight pigmented.	,,	3 8	6 0	2 0	0 12	Lachrymation, slight œdema hind limbs and sheath.
40	Dark Brown Mare	Fair size	Poor	19th ,,	102·2	Swarming.	,,	Slight ulceration	Diseased	3 6	8 6	3 2	1 0	Lachrymation, slight œdema hind limbs. Lungs seat of consolidation, etc., as in No. 814.
273	Brown Gelding	Moderate	Fair	21st ,,	102	,,	,,	Well marked ulceration, thick lining of coats of organ.	Healthy	4 6	8 14	2 4	1 9	Endo-carditis, kidneys large, very pale and œdematous.
G 38	Brown Mare	Small	Moderate	20th ,,	101	Numerous	,,	Slight ulceration	,,	2 5	6 0	2 9	0 11	No œdema, no urticaria.
669	Brown Gelding	,,	Poor	21st ,,	105	Swarming.	,,	Ditto	,,	2 15	7 6	4 2	1 6	Sub-endocardial ecchymoses, kidneys, pale and œdematous.
513	,,	,,	Emaciated	19th ,,	100·3	Few	,,	Marked ulceration	,,	2 5	5 3	2 0	0 10	Liver present signs of old perihepatitis.
57	Brown Mare	,,	,,	20th ,,	101	Swarming.	Died	Extensive ulceration, spiroptera micros.	Diseased	3 4	10 3	1 15	0 11	Consolidation, inferior portions both lungs.
113	Brown Gelding	,,	,,	19th ,,	101·4	Few	,,	Ulceration present	Healthy	3 12	8 11	2 12	1 7	Sub-endocardial ecchymoses, no œdema.

Prevention of Surra.

From what I know of this malady I am convinced that it is impossible to prevent its occurrence in tracts where the disease is endemic. As Government transport have to pass through such tracts every season carrying rations to stations in the Chin Hills, Bernardmyo, and Kengtung, I am of opinion that much can be done towards reducing the terrible annual mortality.

To begin with, now that there are permanent camping grounds on the roads to the Chin Hills and Bernardmyo, and the dates on which the rationing will commence is known for some time previous, I see no reason why a certain number of muleteers under good Non-Commissioned Officers should not be sent off a month before the animals are expected to arrive, to each of the suspicious camping grounds. During this period grass could be collected, dried, stacked in sheds at a trifling cost; ten men working at each camp ought to collect 15,000 to 18,000lb. of grass in a month. In places where paddy straw is procurable, it might also be stacked and used as chaff. I would recommend that these grass cutting parties be permanently employed during the working season. Good fodder can be procured during the months of October, November, December, and part of January. If this suggestion is carried out, sufficient fodder could be collected to carry the animals through the remaining months of the open season. All men selected or volunteering for this employment should be subjected to strict medical examination, and only those who are strong, and who have not been subjected to fever be allowed to proceed. In order to prevent mules grazing while on the march, I would suggest that a muzzle be provided for each animal; they should be put on before the mules leave their standings, and on no account removed till they are tied up at their pickets at the next camp.

As matters now stand, it is impossible to condemn a day's grass-supply, no matter how bad it may be, as the animals would have to go without.

Water-supply.

A good well should be sunk at each of the bad camps. The open wells now found in camps are not to be trusted, as in a great many cases they have been sunk in such low-lying places, that during the rains no trace of them can be seen, thus all manner of filth and organic matter gain entrance into what is supposed to be good drinking water. Tube wells might be employed; they are portable, inexpensive, and I understand easily sunk. These would yield a purer and clearer water than that obtained from open wells, ponds, etc. Two or three troughs or dug-outs for watering purposes could easily be made. A Non-Commissioned Officer should be held responsible that mules are not allowed to water at any place than that provided for the purpose. In the Chin Hills I have seen native trader's ponies, Panthe mules, caravan cattle, all drinking from the same places that Government animals are watered at. All wells, etc., where Government animals are watered at, should, if possible, be fenced in and drinking places provided for outside animals.

Sanitation.

The importance of keeping all camps in a clean state should be impressed on all persons in charge of convoys; every standing should be cleaned and all stable refuse, litter, dung, etc., must be burned daily by a fatigue party, there is no excuse for allowing refuse to accumulate month after month. Where space permits, camping grounds, or rather the standings, should occasionally be changed. Panthes or caravan people should not be allowed to camp on our grounds. Animals must not be crowded; plenty of room between pickets should be allowed to permit free circulation of air.

Animals which are to be sent on rationing might be put on arsenic for some little time before starting; it should also be given in small quantities, now and again, while the animals are working in these unhealthy places, but this of course could not be done until proper supervision is provided. I am of opinion that this drug should not be placed in the hands of Salutris and other natives.

The rationing should be done as quickly as possible, as I feel sure that there would be less Surra if arrangements were made to enable animals to be moved from infected areas by the first week in April. The June outbreaks point to the disease being contracted during the latter end of April and early part of May. Heavy thunderstorms occur about this time followed by excessive moist heat. Organisms which lie dormant during the hot season suddenly become active, and assume fresh phases of development. The rain being particularly heavy, all kinds of active organic matter is washed into tanks, marshes, etc. The tired muleteers are only too delighted to obtain grass near at hand and are not in the least particular as to how they cut it; the result is, that quantities of grass is cut beneath the surface of the water, and, as there is no time to dry it, it is placed before the animals with the portions that have been submerged covered with slime and other filth, which is well known to harbour all manner of low organisms. Fatigue, exposure, indifferent and insufficient food, no doubt, as with other ailments, act as predisposing causes.

In the Military Police we find that the earlier we bring ponies down to the dry zone, the less animals we lose. This year, as far as I am aware, we have not lost any animals out of those brought down from stations like Katha. Last year we did not get them down till end of

May and beginning of June, the losses were very heavy. This season the transport working on the Ruby Mines road did not return to Head-quarters till some time in June; the losses amongst these animals will be terrible. (Between April 1896 and April 1897, 220 mules succumbed to Surra in Mandalay).

Undoubtedly one great fault is the utter want of knowledge of animal management on the part of the natives in charge; some in time may gain experience, still it is expensive for Government. The Salutris and Jemadars I have met over here are incompetent to give any sound advice on matters affecting the health and welfare of animals, and are only just able to treat the most simple ailments. So long as there are defects in the feeding, watering, and general care of Transport, so long will the animals suffer severely from enzootic diseases. While at Head-quarters the greatest care is taken to see that the animals get good dry grass, excellent water, that they are properly and regularly groomed, and that the stables, standings and vicinity are kept in a sanitary condition; yet when these some animals are called upon to perform severe work, and require, if possible, even more care than when in cantonments, they are handed over practically to the tender mercies of Transport Jemadars and Muleteers. These men are very willing, and when looked after, excellent men for the work which should be required of them.

Two points, I wish to bring particularly to your notice, are:—

(*a*) The urgent necessity of providing ample European supervision with Government Transport, and

(*b*) The desirability of getting the rationing over as early as possible, even if extra animals have to be employed.

Hired Transport.

In this Province Bullock and Mule Transport can both be obtained. Pack bullocks are slow, easily stampeded, and as baskets are employed for carrying purposes, it is necessary that Government Packages be undone. The bullocks carry from 140 to 160 lb. The risks of contracts not being fulfilled if foot and mouth disease or rinderpest should attack the animals. The advantage is that it is inexpensive.

Panthe and Yunnanese mule transport, if obtained at moderate rates, must prove a saving to Government. Government has no risks; with mules all work is pretty sure to be carried out. Government could considerably reduce their permanent transport, thus saving keep and establishment.

All work must be pushed through as quickly as possible, as the Panthes are well aware what the results will be if they are kept out too long. These muleteers are willing, cheery, and hardworking, if treated well. The mules being small, they can only carry from 120 to 130 lb., and the men naturally resent any attempts at overloading.

I have little doubt that, if due notice be given, ample transport will be obtained.

When prevalent.

April is the only month in which I have up to the present not met with a case of Surra. The heaviest mortality usually occurs between June and October. June, July and September may, I think, be taken as particularly bad months, though outbreaks severe enough occur in August and November.

As in India we meet with this disease in two different climates, *viz.*, in places where there is a moderately high temperature, an atmosphere charged with moisture, heavy rainfall and considerable inundation of country; also where the climate is dry, the temperature very high, and the rainfall moderate or slight, it must however not be overlooked that in such places, though the register may show only a moderate amount for the year, the rain at times comes down so hard-and-fast that tanks are quickly filled, and low-lying tracts inundated.

Surra prevails at certain seasons throughout Upper Burma, also in the Shan States, and the Chinese say that at times it is very bad in Yunnan. In some years the Chinese suffer heavy losses along the trade routes from Bhamo. In Lower Burma one does not hear so much about Surra, for the simple reason that columns do not go out, and most of the animals are in the hands of private individuals who look after them. In 1890 I witnessed one bad outbreak in the Thayetmyo district. Steel saw it in Toungoo and Rangoon. I have to note an outbreak amongst some private animals in Rangoon. The first case brought to my notice was on the 17th of September of this year, and is the first case I have met with in an animal that had not been out of the station. I will let you have some notes on it later on.

It is surprising that Burmans, owing to their system of feeding ponies, do not suffer heavier losses; the grass is chopped up and mixed with water; grain is frequently given in the same way. The reasons given me are (1) That their forefathers always fed animals in this way and found it answer well, (2) That ponies must digest their food as they cannot bolt it, (3) That owners are too lazy to clean the grass and grain, so mix it with water. This is probably the correct reason. A great many cases must arise from eating bad grass; we all know the customs of ordinary grass-cutters, so we can hardly blame the tired muleteers

for obtaining grass with the least possible labour from swamps, ponds, or the beds of recently dried tanks or nullahs. The state of these latter places just as the evaporating process approaches completion, is horrible, simply a mass of foul smelling, putrid green slime containing myriads of low organisms Stacking grass would, at least to a great extent, protect animals against this source of infection.

Period of Incubation.

I regret I cannot afford any accurate information, I should think from twenty-five to seventy days or even longer.

Mules and ponies, old and young, male and female, of all sizes and colours are attacked and die of the disease. I do not believe that sex, age, colour, or breed exercises any influence in the matter. Animals in the "Pink" of condition succumb as, or even more rapidly than, those that are weak and in a debilitated state. Burman ponies and Pantbe mules contract the disease as readily as imported animals. We will no doubt hear a good deal about flies serving as transmissive agents, now that Dr. Bruce has established the fact in connection with the "Nagana" or "Tsetse-fly" disease. As in South Africa I am certain the flies possess specific venom; though I have never served in Africa I venture to state that certain tracts in this province could compete very favourably with the special "fly tracts" of any other country. In Burma they are particularly bad after the first few thunderstorms, *i. e.*, the end of April and early part of May; indeed they are so troublesome that Burmans when obliged to take carts, etc., etc., through them, take the precaution of making torches of strips of bark of one of the wood-oil trees, I think the *Dipterocarpus Laevis*, Burmese (Kanyin-ni). After lighting the torches, they tie a bundle of green twigs with leaves on to make them smoke well,—one is tied to the yoke between the oxen, the driver carries another to protect himself, and drive the ies from the back and sides of the bullocks. In spite of these appliances men and animals are often severely bitten. Baggage elephants, with trunks and tails swinging, do record trips through such places. I have not observed the cattle or ponies in these parts looking any worse than animals out of these tracts. The Burmans laugh at the idea of these flies provoking any ailment beyond sores at times resulting from the bites. I have frequently examined many kinds of horse and cattle flies in different tracts, and at different seasons of the year, but so far without results. If flies are removed from the body of a Surra patient, Hæmatozoa may now and again be seen, but I examined many specimens before I detected them, and then only in a fly which had been feeding on soiled blood.

That flies may carry soiled blood I am prepared to admit, the ordinary '*Bara Dhang*' could easily do this; still I am of opinion that only a small percentage of animals become infected in this manner; however, time may show that they carry the Hæmatozoon about, a great deal more than we at present give them credit for. Feeding on coarse rank grass which wounds the mouths, tongues, of animals endeavouring to eat it, affords ample means for the entry of the infusorian, especially so when they have to eat marsh grasses, after a course of thatch grass and drink bad water. There can be no question that the Hæmatozoon is the cause of the malady; it is to be found in all cases of Surra, and all equines in which it is seen, as far as my experience goes, will most assuredly die.

I have often heard men say that they have known Burman doctors to cure Surra, and that, when stationed at such and such a place, a Burman cured two cases, etc., etc, such animals having, to their certain knowledge, worked for two years after. These were, no doubt, cases of that peculiar form of bilious fever which very closely resembles Surra in many of its symptoms, and which I described to you. You also met with the same disease in Poona. I think, we can safely say, that no Burman ever cured a case of the disease we know as Surra.

I have given Burmese doctors every opportunity and assistance, and have offered a large reward; though they have on several occasions accepted my offers, they have after a week's trial given the patients up as hopeless, stating that they had mistaken the nature of the malady.

No doubt the most striking feature of the disease is the wonderful appetite of the affected animals, and the manner in which they (in spite of food) rapidly become living skeletons. It is a distressing sight to see an animal down, with its heart thumping violently, and veins of head distended, still struggling to eat. I have many times seen an animal drop dead while eating, and have several times propped them up when unable to stand into the lying posture, when they have at once commenced to feed and have died in from twenty to thirty minutes after. Even with very high temperatures they will always take grass, but may refuse grain.

Urticaria is not nearly so common as in Indian cases; œdema is common enough, especially among the larger patients.

Constipation is the rule; diarrhœa the exception; the dung natural at first, later on is of a light brown colour, towards the close it is frequently pultaceous and possesses a foul odour.

The urine from Surra patients varies a great deal, sometimes viscid, at others not; in colour varies from a reddish to a greenish yellow. As a rule, it is alkaline in reaction, but towards the close is often slightly or distinctly acid. I have failed to detect the organism in the urine, but blood and granular casts are common enough; in some cases small quantities of albumen may be present.

Spiroptera nests are distinctly rare. During this season I have made upwards of sixty *post-mortems*, and in only one case did I observe a nest.

Ordinary parasites are constantly met with, and now and again flukes. This year I came upon a very bad case, there must have been quite two hundred parasites in the liver, which organ was much enlarged.

Flies.

Like yourself I have failed to detect anything like the Surra Hæmatozoon in jungle flies, and I have examined a very great number. They were just coming out in myriads when I visited the jungle.

There is a species of fly which, from the accounts of its bite, I should say, is capable of inoculating healthy animals, *i. e.*, granting Surra cases were mixed amongst healthy animals. From the accounts of the fly and the peculiar appearance of the bite, I think, it is similar to or identical with the fly met with at Thandaung in the Karen and Binjiji in the Shan Hills. This fly is a little larger than the ordinary house fly, but varies in size; its body is yellowish in colour, the legs being bent on themselves. At the point where this fly bites, a small extravasation of blood appears just under the skin, which shortly after presents the appearance of a blood bleb, such as follows a contused wound.

I will examine the flies in one or two localities I know, but they are so terribly unhealthy, that one is quickly driven out by one's servants being rolled over with fever.

We are getting some thunderstorms and this is the time when I am sure that the animals contract the disease; the water is at its very worst and is stirred up with all manner of filth. The flies at this time are present in great numbers.

One thing about the Surra being the same as the South African malady, is that wild animals do not appear to die of it; surely they cannot be all immune. Animals like the *Gaur* (Indian bison), *Tsaing*, etc., would be sure to catch it, but they never do, from all I can learn. Rinderpest, foot-and-mouth disease they do get, yet these animals live in heavy jungle where the flies are so annoying to them that they have to go in the open to escape.

Again, consider those cases that occurred amongst mules working between the Commissariat Lines and the shore at Mandalay. There is no jungle there and horse flies were not troublesome. At that time there were no cases of Surra in Mandalay, at least that we knew of. I also lost two or three animals belonging to the Military Police, and these had never left the station during the season.

I am informed that a great deal of Surra prevails between Taung-gyi and Keng-tung. There is a considerable area of swampy country about, and flies are very troublesome while passing through forest tracts.

As Military Police ponies have to go to unhealthy outposts, I have recommended that animals posted after 15th March should be allowed to remain at such places throughout the season. It is a pity to relieve the ponies every time the men are changed, for it often means that most of the ponies in a Battalion become infected instead of a few.

SURRA OUTBREAK AT RANGOON.

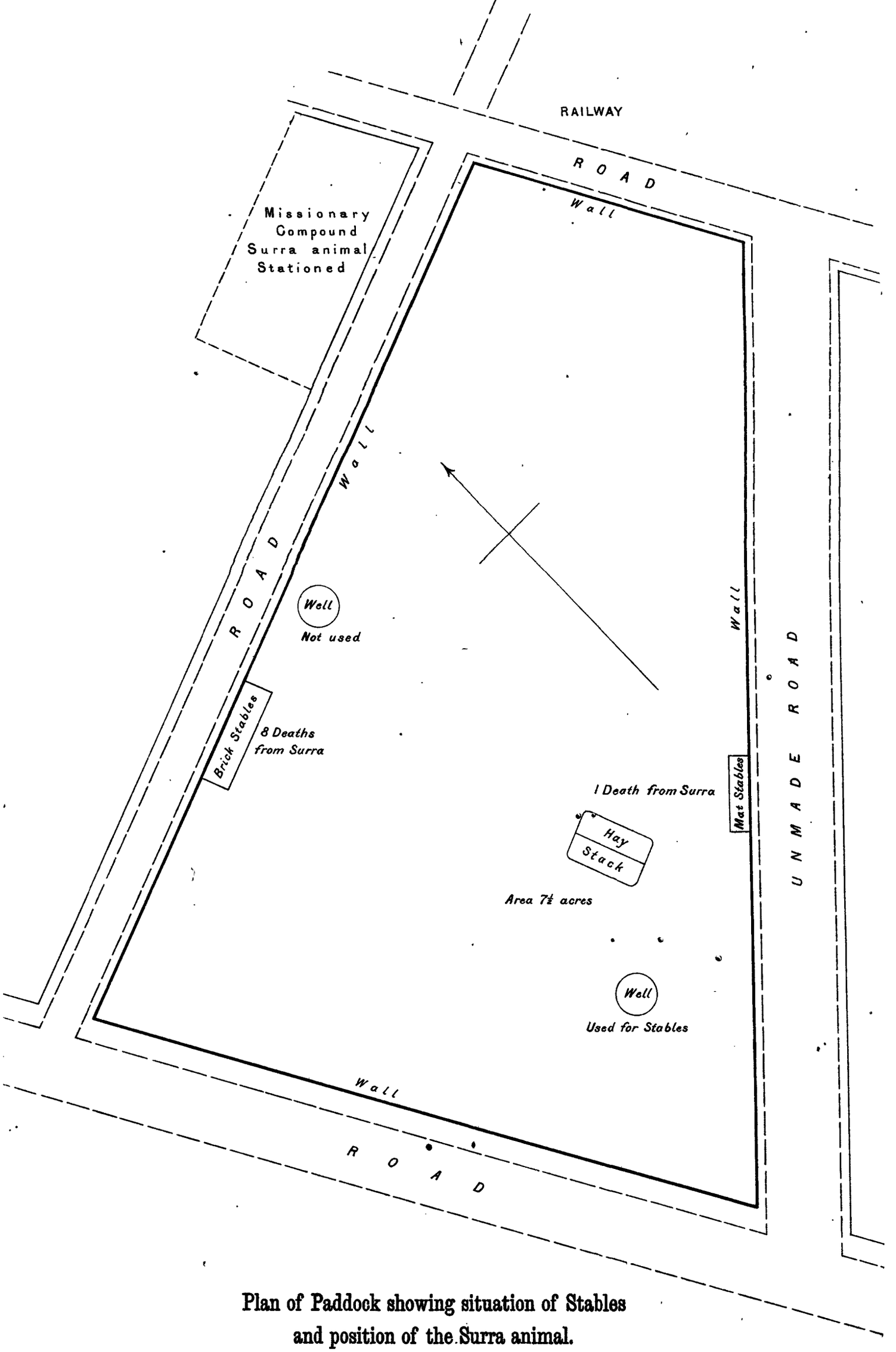
Veterinary Captain Evans narrated the following account of an outbreak of Surra in a private stable in Rangoon during his recent visit on deputation to Muktesar. As it is of such importance to owners of equines in many districts of India, where the disease is enzootic, I have added it to this officer's notes on Surra previously recorded.

On September 17th, 1896, an outbreak of Surra occurred in the cantonment, among the horses belonging to a civilian; no case had been observed during the previous seven years in Rangoon, with the exception of two or three animals which arrived from Upper Burma with the disease. In these the malady was speedily diagnosed and the ponies destroyed.

The animals kept by the above gentleman consisted of selected country-breds, Burman ponies and one Arab. The stables were pucca built and the best in that part of Burma, being situated on high ground, in an open compound, seven and-a-half acres in extent, and surrounded by a stone wall. The grass supplied to the animals was specially brought in from high ground some five miles distant, where it had been procured for some years past. The water was obtained from a pucca well in the compound. The grain 'crushed food' was the same as that supplied to most stables in the station and procured from Calcutta.

The stable containing the Burmans and Arab were situated on the south side of the paddock, while the country-breds were kept in a stable on the north side and in close proximity to the adjoining compound, only a road intervening. Eight animals died or had to be destroyed within 14 days on account of having contracted Surra, and veterinary surgeons and owner were nonplused as to how the animals could possibly have contracted the disease. Just at that time a break occurred in the rains, and, as always happens, under such circumstances, flies were very numerous and aggressive. A few days later it came to notice that a pony was ill in the adjoining compound. On microscopical examination of its blood the Surra Hæmatozoon was found to be teeming. This animal received green grass as fodder, from anywhere the grass cutter could most easily obtain it. As all the animals with the exception of the Arab were allowed to run free in the compound, it is more than probable, therefore, that flies were the means by which the contagium of Surra was carried.

This outbreak only tends to emphasise the importance of recognising Surra at the first possible moment, in order that the subjects may be destroyed forthwith, and so do away with a focus for the dissemination of the disease by flies.



Plan of Paddock showing situation of Stables and position of the Surra animal.

Scale 1 Inch = 100 Feet.

APPENDIX III.

A.—SURRA IN BOVINES AND BUFFALOES.

B.—INVESTIGATIONS *re* SURRA.

APPENDIX III A.

Surra in Bovines and Buffaloes.

The course which Surra takes in bovines, when acquired either spontaneously or after inoculation, has been very briefly pointed out in my earlier reports on this disease. It will be as well, however, to recapitulate the leading facts known concerning these animals, in order to compare them with the symptoms and course of Surra in buffaloes now recorded for the first time.

Some five or six bovines were subjected, at Poona, to inoculation with the *Trypanosoma* from different animals, *viz.*, horse, rat, and the latter organism after it had been passed through equines. All these animals survived the first attack of the disease, and subsequently were respectively exposed to re-inoculation with material obtained from a more virulent source to that injected on the first occasion. In no instance did any serious symptoms follow as a consequence, but at a later period, Bull No. III and the calf contracted rinderpest spontaneously, and succumbed to it, 232 and 234 days respectively, after the date of their re-inoculation with Surra.

In the following *précis* will be found the chief facts noted in the case of each animal together with a tabular statement, giving the fullest details.

Bull No. I.—Deccani bred. This animal was kept under observation for some time, during which it appeared quite healthy. It was sub-cutaneously inoculated on the 24th March 1891 with 1·75 c.cm. of blood, containing numerous Surra Hæmatozoa taken from the jugular vein of Horse No. XIX. A considerable amount of swelling and œdema, with tenderness on manipulation followed at the seat of inoculation. On the evening of the 28th May the temperature rose to 39·7 °C., and on the following morning one Hæmatozoon was discovered on microscopical examination after searching through several specimens of blood. On the 30th no Hæmatozoa were found in the blood, but on the 31st and 1st April a few were observed. From this date until the 17th June no more Hæmatozoa or their immature forms were seen, although carefully searched for. On 17th June eighty-five days after the inoculation of the animal, two Guinea-pigs were inoculated sub-cutaneously with 0·2 c.cm. No. I Guinea-pig developed Hæmatozoa in the blood on the 27th, ten days after inoculation, whilst No. II Guinea-pig did not develop any until the 5th July, or eighteen days after inoculation. The organisms were present off and on in the blood of these animals for a considerable period. No. I finally succumbing to the disease on the 8th of November 1891, or 144 days after its inoculation, whilst No. II died on the 12th October 1891, or 117 days after inoculation.

During the interval which elapsed between the 17th June and 3rd September 1891, no Hæmatozoa were discovered in the blood of the bull, although several cover glass specimens of it were examined every day. Consequently two more guinea-pigs were inoculated. These were distinguished as No. III and No. IV and each received 0·2 c.cm. of blood from the bull on the 163rd day after its inoculation. Nos. III and IV Guinea-pigs both developed Hæmatozoa on the 10th day and the organisms remained almost constantly present in their blood until the day of their death, 24th October and 14th December, respectively.

On the 13th November 1891, that is, 234 days after the inoculation of the bull, two Guinea-pigs Nos. V and VI were inoculated with 0·2 c.cm. of blood from that animal, but as no Hæmatozoa were found during the next 32 days, they were re-inoculated on the 16th December 1891, 267 days after the inoculation of the bull, but with negative results a second time. Between the latter date, 16th December 1891, and 14th March 1892, the bull appeared to be enjoying good health and putting on flesh. On this latter date, that is, 356 days from the time of inoculation, two new Guinea-pigs Nos. VII and VIII were inoculated as previously with 0·2 c.cm. of blood from the bull, but this experiment was also followed by negative results. Since 24th March the bull has been in very fine condition, and as it was desirable to ascertain whether animals of the bovine species are liable to a second attack of Surra, it was resolved to re-inoculate this animal with a more virulent type of Surra, obtained by passing the Hæmatozoon of the rat (*Mus decumanus*) through the horse and donkey. This second inoculation was performed on the 22nd August 1892, when 1·0 c.cm. of blood drawn from the jugular vein of the donkey, was sub-cutaneously injected over the left scapular region, the blood at the time containing very numerous and active Hæmatozoa. No swelling and œdema followed, only slight sub-cutaneous thickening in the tract of the injective needle. On the 28th of the same month a peculiar organism was found in the blood, but on that day only. The animal put on flesh and appeared in robust health. On 21st September 1892 two Guinea-pigs were inoculated with blood drawn from the jugular vein, but up to the 14th November 1892, their blood, which had been examined daily, failed to show any signs of the Surra Hæmatozoon.

The blood of Bull I, was submitted to microscopical examination until the 22nd July 1893, a period of 345 days after the date of the second inoculation. No Surra Hæmatozoa were observed, but only one giant form of Trypanosoma on 27th August 1892.

Bull No. III, aged 4 years.—This animal was sub-cutaneously inoculated on the 31st July 1892, with 1·0 c.cm. of blood containing very numerous Hæmatozoa taken from the jugular vein of Horse No. LXVII, previously passed through the horse from the rat (*Mus decumanus*). A considerable amount of swelling and œdema with tenderness on manipulation followed at the seat of the injection.

The latent period occupied three days. The Hæmatozoon was present in the blood from the 3rd to the 9th August inclusive. After an interval of thirteen days it was again present in small numbers for two days, August 23rd and 24th. After a second interval of nine days it re-appeared for one day on the 3rd September. During a further period of 158 days accompanied by daily microscopical examination of the blood, no organisms were observed. The temperature became rapidly elevated after inoculation and attained a maximum of 41·4°C. on the 4th day of the disease, and then gradually fell until the morning of the eighth day when it registered 38·8°C. It again rose to 41°C. on the 37th day. The pyrexia, since November 14th, has been characterized by morning remissions and evening exacerbations especially on the 143rd, 155th, 156th, 168th and 178th days of the disease. During the months of August and September this animal became greatly emaciated, but by December had put on a considerable amount of flesh and appeared quite healthy.

On the 3rd September 1892, the 191st day after inoculation, and the 158th since the last appearance of the organism in the blood, it was decided to re-inoculate the animals with Horse Surra blood, in order to test whether any protection had been acquired from the previous inoculation. Consequently on 9th February 1893 the animal was re-inoculated sub-cutaneously with 2·0 c.cm. of blood drawn from the jugular vein of Horse No. LXXXIV immediately after death, but which just before death contained numerous Hæmatozoa.

No swelling or œdema followed but there was only a slight thickening of the tissues on the fourth day at the seat of the injection of blood. Three paroxysms occurred, *viz.*, on the 1st, 111th, and 233rd days, lasting 1, 3 and 3 days, with two intermissions occupying 109 and 120 days respectively.

The animal contracted rinderpest on the 26th September 1893, although isolated with several other bovines in an enclosed area, surrounded by a wall 7 feet in height, and succumbed on the 28th September.

Bull No. IV—was inoculated on July 27th, 1892, with 2·0 c.cm. of blood containing the Hæmatozoon, taken from the rat (*Mus decumanus*) immediately after death. A considerable amount of swelling and œdema followed at the seat of the injection which gradually decreased in extent and finally disappeared about the 10th August 1892. From the 27th July until October 10th, 1892, the blood remained free from the Hæmatozoon. On the evening of the 9th September an urticarial eruption broke out on both sides of the neck, chest and scapular regions, but had disappeared entirely by the following morning. On the morning of the 3rd October, a similar eruption to the former made its appearance and again faded the same day. On microscopical examination of the blood on the 11th October, the 76th day after inoculation, a long and active trypanosoma was discovered, the dorsal membrane being particularly well developed. From the latter date up to the 9th February 1893, the 121st day of the disease, no further Hæmatozoa were observed, although serveral specimens of the blood were subjected to careful microscopical examination daily. The temperature on the morning of the 8th day following inoculation attained a maximum of 41 °C., but by the following morning had fallen 2 ° C., and although it subsequently, on numerous occasions, reached 40·°C., it has only risen to 40·3°C. From November 16th the pyrexia was characterized by marked morning remissions and evening exacerbations, especially on the 55th, 56th and 59th day of the disease when the morning and evening temperatures varied from 2·5°C. to 3·°C. (4·5 to 5·4°F). The animal lost flesh during the months of August, September, October and November, but in January 1893 began to put on flesh.

On February 9th, 1893, 197 days after the inoculation with rat's blood and 121 days after the first and last appearance of the Hæmatozoon in the blood, it was decided to inoculate the animal with Horse Surra blood in order to test whether any protection had been acquired from the previous inoculation. Consequently the animal was sub-cutaneously inoculated with 2·0 c.cm. of blood, containing numerous Hæmatozoa drawn from the jugular vein of Horse No. LXXXIV immediately after death. No swelling followed at the seat of the injection, but on February 14th the muzzle became hot and dry, and there was considerable fever,* lasting several days, but the Hæmatozoon was not discovered, although the blood of the animal was collected and examined microscopically three times daily during the period the fever lasted. On the 30th of April, 80 days after the re-inoculation, the Hæmatozoon was observed in small numbers and remained in the blood for 48 hours, after which it disappeared and was absent until the 18th July 1893, a period of 78 days ; when it was again present in small numbers for one day. From this date until the 29th January 1894, a period of 195 days, the Hæmatozoon was never found, although daily examinations of the blood were made. The animal unfortunately met with an accident, broke its leg, and consequently had to be destroyed.

The chief points of interest in this case are that—

(i) This is the first case recorded of any animal of the bovine species having been successfully inoculated with the Hæmatozoon of the rat (*Mus decumanus*).

Two guinea-pigs inoculated on the 21st September 1892 with 0·3 c.cm. of blood in which no Hæmatozoa could be discovered microscopically, contracted Surra after a latent period of 14 days.

* It is possible that the Hæmatozoon was present in very limited numbers during the presence of the fever between the 13th and 16th February 1893.

Two Guinea-pigs inoculated on the 21st September 1892 with blood from this animal in which no Hæmatozoon could be discovered, failed to contract the disease.

(ii) The amount of swelling and œdema which followed inoculation, at and around the seat of the injection, finally disappeared on the 14th day after the operation; also the temperature 41·°C. (106·8°F.) registered on the morning of the 8th day.

(iii) The protracted period of incubation of the disease, whether we take it as terminating on the first appearance of the urticarial eruption on the 44th day as previous experience points to the Hæmatozoon being the cause of the manifestation in the skin or on the 75th day when the organism was found for the first time in the blood. In either case the length of the latent period 63 days, has only once been exceeded, *viz.*—in Horse LXII which was inoculated with soiled rat's blood.

(iv) The discovery of the 'Trypanosoma' in the blood on the 76th day after inoculation, when a long and active specimen of the organism was alone observed; the dorsal membrane in which was particularly well developed. The absence of further specimens from the blood, during a prolonged period of 121 days.

(v) The marked evening exacerbations and morning remissions of temperature which occurred on the 55th, 56th and 59th days of the disease.

(vi) The loss of flesh during the months which immediately followed inoculation.

(vii) Re-inoculation of the animal with Horse Surra 197 days after the former injection of soiled rat's blood, followed by high fever, but a total absence of swelling at the seat of inoculation.

(viii) The appearance of the Surra organism in the blood for a period of 48 hours, 80 days later, and re-appearance for 24 hours on the 158th day, but total absence during a further period of 195 days.

Cow.—The experiment determined upon, had for its objects :—

(i) If Surra is communicated to a cow in milk sub-cutaneously, does the Hæmatozoon or its immature form pass from the general circulation into the milk?

(ii) Will a calf suckling its mother, under such conditions, contract the disease?

A cow with a calf three weeks old at her side, contracted Surra.* The blood of the mother was found to contain the Hæmatozoon for a period of 120 hours. The calf was allowed to suckle three times in the twenty-four hours, and the milk from each teat was daily examined microscopically for the presence of the organism; but this was never discovered. On the 38th day from the appearance of the Hæmatozoon in the circulation of the mother, it appeared in the blood of the offspring, which up to that date had been free. The organism remained in the circulation for 24 hours only, and had not re-appeared 123 days later.

Blood in small quantities must have become mixed with the milk, owing to rupture of some small mammary vessels, and by this means the Hæmatozoon entered the digestive tract of the calf.

On February 9th, 1893, the calf having grown considerably and being in good condition it was decided to re-inoculate it, with a view to ascertain whether the animal had received any protection from the presence of the 'Trypanosoma' in its circulation. Consequently the same evening the calf received sub-cutaneously 1·0 c.cm. of blood taken from the jugular vein of Horse No. LXXXIV immediately after death. No local manifestation followed at the seat of the injection. The latent period occupied a little over three days, the Hæmatozoon being present for two days, February 13th and 14th, and again for one day (18th) after an intermission lasting 72 hours. From the 18th February, until September 30th, 1893, a period of 224 days, the organism was present in the blood once and then only for a few hours, *viz.*, on the 22nd June, 123 days after its last appearance.

The animal contracted rinderpest, the first symptom appearing on the 28th, and succumbed to that disease on the 30th September 1893.

A similar experiment with the same end in view as in the case of its offspring was initiated in the cow. It was re-inoculated on the 9th February 1893, with 2·0 c.cm. of blood containing numerous Hæmatozoa taken from the jugular vein of Horse No. LXXXIV immediately after death. The latent period occupied 8½ days, no local manifestations being observed at the seat of the injection. From the first appearance of the organisms in the blood on the 18th February 1893, until 31st May 1894, six paroxysms each lasting 1 or 2 days occurred, the Hæmatozoon never exceeding two in a field of the microscope. The length of the intermissions were, 10, 29, 70, 9, 128 days; but as the examination of the blood was discontinued on May 31st, 1894, 214 days since the last appearance of the organism in the blood, it is very unlikely that the Hæmatozoon would have again appeared in the circulation. On this latter date, the animal was in good health and in very fair condition.

Hissar Bullocks at Karnal.—In two cases of spontaneous Surra in bovines (Hissar bullocks) observed at Karnal during the months of December 1895 and January 1896, the animals had been ailing for some four months but thin and emaciated during the eight weeks prior to my visit. In both these cases the attack of Surra was complicated by the presence

* During the latent period, there was no swelling or œdema observed at the seat of the injection of blood, although a slight thickening would be felt in the sub-cutaneous tissue.

of large numbers of the *Filaria papillosa* in the blood, in addition to varying numbers of the *Trypanosoma Evansi*. For three days previous to the death of No. 13 the temperature ranged between 95° and 105° F., a variation of ten degrees, but at the autopsy few pathological changes were noted, and those of a slight character.

No. 152 Bullock, which presented quite as an advanced condition of Surra as the one that succumbed, very gradually recovered. At a later date, September 1896, had put on flesh and presented a good condition, although for some time it was quite off its feed, and only ate when tempted by lucerne grass placed in its mouth. The temperature in this case ranged between 99° and 107° F., and for a considerable period after the special Surra symptoms had passed the morning remissions and evening exacerbations of temperature were most marked. This fever of an intermittent type was not due to Surra or Filariasis only, alone or combined, but was a special form of disease of malarial origin. For at Karnal malarial fever in bovines and equines appears alone, as well as complicating other disorders.

Bull V (Hill animal), aged two years, was kept under observation from the 27th November, 1896, until 15th February, 1897. On the 16th February it was inoculated on the ear, a minute incision being made and a trace of blood containing a few Hæmatozoa, taken from Buffalo I, was placed between the edges of the wound. The latent period occupied six days. The Hæmatozoon was present in the blood from the 1st to the 3rd of March inclusive. After an interval of three days it was again present in large numbers for four days, March 7th to the 10th; after a second interval of five days it re-appeared for one day on the 16th March. During a further period of 147 days, accompanied by daily microscopical examinations of the blood, no organisms were observed. During the period of observation lasting 89 days the temperature varied between 39·3° and 36°C., and between 38·9° and 37·1°C. during the latent period of the disease. On the appearance of the Hæmatozoon the temperature became rapidly elevated and attained a maximum of 42·5°C. (108·5° F.) on the third evening, and then gradually fell until the morning of the 7th day of the disease; when it registered 37·5°C. It again rose to 40·5°C. on the 9th, and remained at that point until the evening of the 10th day, when it fell to 37·4°C. The pyrexia since March 11th has been characterized by morning remissions and evening exacerbations, especially on the 42nd, 49th, 58th, 102nd, 116th, 125th days of the disease. During the months of May, June, and July, this animal became greatly emaciated, but during August commenced to put on flesh and fill out again.

August 31st, 1897.—This animal is now in fair condition; the hæmatozoon has been absent from the blood since March 15th, 1897, a period of intermission lasting 168 days up to date.

TABLE IV.

Showing the Paroxysms and Intermissions registered during the case, together with the variations in numbers of Hæmatozoa recorded in the paroxysms, and temperatures during each period.

Period.	No. of days.	Hæmatozoa varied from	Temperature.		Period.	No. of days.	Hæmatozoa varied from	Temperature.	
			Maximum	Minimum.				Maximum.	Minimum.
			°C.	°C.				°C.	°C.
Observation .	89	...	39·3	36·0	Paroxysm II .	4	Few—swarming	40·5	37·5
Latent Period .	6	...	38·9	37·1	Intermission II	5	...	38·6	37·0
Paroxysm I .	3	Few—swarming	41·5	37·4	Paroxysm III	1	Few—few	38·6	37·5
Intermission I .	3	...	40·0	37·5	Intermission III.	147	...	41·0	37·1

Buffalo No. I (Genus-Bubalus), aged 2½ years, was kept under observation for a period of 44 days previous to inoculation (16th November 1897) on the muffle with a trace of blood containing swarms of Surra Hæmatozoa. The material was taken from a young cat, which had previously been inoculated from a Surra horse in the plains. No change was observed at the seat of the small incision, between the edges of which the soiled blood was placed. The latent period occupied five days. The time which elapsed between the first appearance of the Hæmatozoon and death, *viz.*, 120 days, was made up of 12 paroxysms lasting 39, and 11 intermissions lasting 81 days. During the course of the disease the animal lost flesh, and towards the last became somewhat emaciated, notwithstanding the voracious appetite which was maintained until two days before death.

TABLE V.

Showing the Paroxysms and Intermissions registered during the case, together with the variation in numbers of Hæmatozoa recorded in the paroxysms and temperatures during each period.

Periods.	No. of days	Hæmatozoa varied from	Temperature. Maximum.	Temperature. Minimum.	Periods.	No. of days	Hæmatozoa varied from	Temperature. Maximum	Temperature. Minimum.
			°C.	°C.				°C.	°C.
Observation .	44	.....	39·5	35·4	Intermission VI .	6	.....	38·3	36 1
Latent period .	5	.....	38·1	35·4	Paroxysm VII .	2	Few—few .	37·7	36·1
Paroxysm I .	3	Few—numerous .	39·5	37·0	Intermission VII	14	.....	38·4	35·2
Intermission I .	3	.....	38·8	36·4	Paroxysm VIII .	4	Few - numerous	38·2	36·9
Paroxysm II .	6	Few—numerous .	39·6	35·8	Intermission VIII	8	.....	38·5	37·0
Intermission II .	5	.....	38·5	35·9	Paroxysm IX .	2	Few—few .	38·0	36·9
Paroxysm III .	2	Few—numerous .	39·4	36·4	Intermission IX .	14	.....	38·2	36·2
Intermission III .	8	.....	39·0	36 0	Paroxysm X .	3	Few—very numerous.	37·4	36·2
Paroxysm IV .	4	Few—few . .	38·2	36·2	Intermission X	7	.....	39·2	36·2
Intermission IV .	6	.....	38·6	35·5	Paroxysm XI .	5	Few—numerous	38·6	36·1
Paroxysm V .	2	Few—few . .	37·5	36·0	Intermission XI	5	.....	37·4	36·0
Intermission V .	5	.....	38·0	36·0	Paroxysm XII .	3	Few—swarming	36·8	35·1
Paroxysm VI .	3	Few—few . .	38·2	36·2					

Autopsy at 1 P.M., two hours after death. Body weight 261 lb. The body is somewhat emaciated, and *on section*, no sub-cutaneous adipose tissue is seen. The cymphatic glands of the neck are somewhat increased in size.

The pleural cavities are free from fluid and there are no pleuritic adhesions.

The lungs are fully distended with air, the left organ being the seat of hypostatic congestion. *On section*, the tissues present a healthy appearance.

There are 15 c.cm. of a clear straw-coloured fluid in the pericardial sac.

Heart.—The base is surrounded with a semi-solid jelly, in place of the fat usually found in that position. The external surface of the organ is free from extravasations of blood or small petechiæ. *On section*, the internal surface of the endocardial sac is free from extravasations, and the valves are healthy.

The peritoneal cavity is free from fluid.

Liver weighs 3 lb 13 ozs., somewhat small. Glisson's capsule free from old or recent signs of inflammation so frequent in equines which have succumbed to Surra. *On section* the tissues present a healthy appearance.

Spleen weighs 14 ozs., normal in size and consistency. *On section*, tissues present a healthy appearance.

Kidneys.—Right weighs 6 ozs., left 6 ozs. The capsules strip easily. *On section*, tissues healthy in appearance.

Rumen, Reticulum, Omasum and *Abomasum* healthy.

Large and small intestines present healthy appearance.

	lb
Stomachs and intestines with dung weigh	86
„ „ without dung weigh	22
Weight of contained dung	64

Buffalo No. II, aged 2½ years, was kept under observation for a period extending over 45 days previous to the commencement of the experiment. On January 14th, 1897, the animal was inoculated with Surra in the ear. For this purpose a minute incision was made in the skin covering the tip of the right organ, and a minute drop of blood containing a few Hæmatozoa, taken from buffalo No. I, was inserted between the edges of the wound. No local manifestations of any kind were observed to follow the inoculation, but on the morning of the 20th, after a latent period of a little over five days, the Hæmatozoon appeared in small numbers in the blood. The time which elapsed between the first appearance of Hæmatozoon and death, *viz.*, 46 days, was made up of seven paroxysms lasting 15, and seven intermissions lasting 31 days. During the course of the disease the animal lost flesh, and before death took place became emaciated, in spite of the appetite which was present until several days before the animal succumbed.

TABLE VI.

Showing the length of the Paroxysms and Intermissions registered during the case, together with the variation in numbers of Hæmatozoa recorded in the paroxysms and temperatures during each period.

Period.	No. of days.	Hæmatozoa varied from	Temperature.		Period.	No. of days.	Hæmatozoa varied from	Temperature.	
			Maximum.	Minimum.				Maximum.	Minimum.
			°C.	°C.				°C.	°C
Observation .	45	.....	39·2	35·0	Paroxysm IV .	1	Few . .	37·5	37·1
Latent Period .	5	.....	38·4	36 0	Intermission IV .	9	.....	38·2	36·5
Paroxysm I .	1	Few . . .	38·4	37·6	Paroxysm V .	1	Few . .	37·1	36·8
Intermission I .	2	.....	39·0	36·0	Intermission V .	8	.....	38·4	36·2
Paroxysm II .	2	Swarming .	40·0	36 0	Paroxysm VI	2	Few . .	38·0	36·6
Intermission II .	4	.....	39·0	36·0	Intermission VI .	4	.....	38·4	36·4
Paroxysm III .	4	Few – numerous .	37 9	36·5	Paroxysm VII .	4	Few . .	37·8	36·2
Intermission III	1	.....	37·9	36·5	Intermission VII	3	.....	37·2	36·0

Autopsy at 11 A.M., twelve hours after death. Two leeches came out from the nostrils shortly after the death of the animal.

The body is somewhat emaciated, and *on section*, there is an entire absence of sub-cutaneous adipose tissue.

Thorax.—The pleural cavities contain a small amount (30—40 c.cm.) of a semi-opaque fluid. There are no pleural adhesions.

Lungs weigh 4lb 6ozs.; are fully distended with air; slight emphysema, left anterior lobe.

The pericardial sac is distended with a light yellow coloured clear fluid.

Heart weighs 1lb 12ozs. The base is surrounded with a semi solid jelly in place of the fat usually present in that position. External surface of the organ presents a healthy appearance.

Right Auricle—healthy.

Right Ventricle contains decolourised clot running up into the pulmonary artery. No sub-endocardial extravasations.

Left Auricle—healthy.

Left Ventricle contracted, decolourised clot. No extravasations.

The peritoneal cavity contains a small quantity (55 c.cm.) of clear straw-coloured fluid.

Liver weighs 3lb 11ozs.; surface and tissues on section present a healthy appearance.

Spleen weighs 10 ozs.; small; healthy.

Kidneys.—Right weighs 6 ozs,. left 6·25 ozs. Capsules strip easily. Tissues appear healthy.

Rumen, Reticulum, Omasum healthy. The abomasum or true stomach on section presents elongated narrow patches of a deep chocolate colour $\frac{1}{8}$ inch in width, dotted over the whole surface of the mucous membrane. This deposit, when carefully scraped, appears to leave the mucous membrane beneath unaltered.

Small and Large Intestines.—Here and there the vessels are infected in their whole length. Occasionally patches two inches in width are observed, deep red in colour, also due to capillary injection. No ulceration.

Bladder healthy.

	lb
Weight of dry dung in intestines	62·75
,, fluid in intestines	5·50
Total weight of dung .	68·25

TABLE VII.

Showing the number of Paroxysms and Intermissions which occurred in the course of each case, together with their duration and other details connected with the cases.

No.	Animal.	1st or 2nd inoculation.	Period of observation. Date. From	To	Number of days.	Fluid used.	Quantity used.	Fluid taken from what animal.	Hæmatozoa.	A. M. or P. M.	Date of inoculation.	How administered.	Date of first appearance of Hæmatozoon.	Latent Period, length in days.	Paroxysm I.	Intermission I.	Paroxysm II.	Intermission II.	Paroxysm III.	Intermission III.	Paroxysm IV.	Intermission IV.	Paroxysm V.	Intermission V.	Paroxysm VI.	Intermission VI.	Paroxysm VII.	Intermission VII.	Paroxysms. Total No. of days.	Intermissions. Total No. of days.	Result.	Date of result.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16														17	18	19	20
I	Bull	1st	19th March 1891.	24th March 1891.	5	Blood	1·75 c.cm.	Horse X'X	N.	...	24th March 1891.	Sub-cut.	29th March 1891.	5	1	1	2	507	...	...	...	...	...	...	...	...	...	...	3	508	...	...
,,	,,	2nd	...	...	...	,,	1·0 ,,	Donkey II	V. N.	A. M.	12th Aug. 1892.	,,	*Ntl.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
III	Bull	1st	24th July 1892.	31st July 1892.	7	,,	1·0 ,,	Horse LXVII	V. N.	,,	31st July 1892.	,,	3rd Aug. 1892.	3	7	13	2	9	1	158	...	...	...	...	...	...	...	...	10	180	...	...
,,	,,	2nd	...	...	...	,,	2·0 ,,	Horse LXXXIV.	N.	P. M.	9th Feb. 1893.	,,	30th March 1893.	49	1	109	3	9	3	58	...	...	...	...	...	...	...	...	7	176	Death	28th Sept. 1893.
IV	Bull	1st	24th July 1892.	27th July 1892.	3	,,	2·0 ,,	Rat (M. Decu.)	N.	,,	27th July 1892.	,,	11th Oct. 1892.	75	1	121	...	...	...	..	...	...	...	...	..	...	...	...	1	121	...	...
,,	,,	2nd	...	...	...	,,	2·0 ,,	Horse LXXXIV.	N.	,,	9th Feb. 1893.	,,	30th April 1893.	52	1?	73	2	77	1	195	...	...	...	...	...	...	...	...	4	345	Killed	29th Jan. 1894.
I	Cow	1st	24th Aug. 1892.	28th Aug. 1892.	4	,,	1·0 ,,	Donkey II	V. N.	A. M.	28th Aug. 1892.	,,	2nd Sept. 1892.	5	5	55	1	18	1	21	2	58	...	...	..	...	...	...	9	152	...	...
,,	,,	2nd	...	...	...	,,	2·0 ,,	Horse LXXXIV.	N.	P. M.	9th Feb. 1893.	,,	13th Feb. 1893.	9	1	10	1	29	2	70	1	3	1	128	2	214	...	...	8	460	Cured	...
I	Calf	1st	24th Aug. 1892.	28th Aug. 1892.	4	Milk	*Ad libitum*	Cow I	?	A. M.	2nd Sept. 1892. / 9th Oct. 1892.	Gastric Ingestion.	9th Oct. 1892.	?	1	123	...	...	...	...	...	...	...	...	...	...	...	...	1	123	...	...
,,	,,	2nd	...	...	...	Blood	1·0 c.cm.	Horse LXXXIV.	N.	,,	9th Feb. 1893.	...	14th Feb. 1893.	4	2	3	1	123	1	100	...	...	...	...	...	...	...	...	4	226	Death	30th Sept. 1893.
V	Bull	1st	26th Nov. 1896.	16th Feb. 1897.	89	,,	m i	Buffalo II	F.	,,	22nd Feb. 1897.	Sub-cut.	1st March 1897.	6	3	3	4	5	1	147	...	...	...	...	...	...	...	...	8	155	Cured	...
I	Buffalo	1st	4th Oct. 1896.	17th Nov. 1896.	45	,,	m ij	Cat VI	S.	,,	16th Nov. 1896.	Sub-cutaneous minute incision.	22nd Nov. 1896.	5	3 / VI / 4	3 / II / 8	6 / I X / 2	5 / 14	2 / X / 3	8 / 7	4 / X / 5	6 / I / 5	2 / X / 3	5 / II / ...	3 / ...	6 / ...	2 / ...	14 / ...	39	81	Death	21st March 1897.
II	Buffalo	1st	1st Dec. 1896.	14th Jan. 1897.	45	,,	m i	Buffalo I	F.	,,	14th Jan. 1897.	In minute incision.	20th Jan. 1897.	5	1	2	2	4	4	1	1	9	1	5	2	4	4	3	15	31	Death	5th March 1897.

Bull No. I.—On 27th August 1892 organism was observed in the blood resembling a very large Surra *Trypanosoma*. The length was equal to the diameter of 14 red blood corpuscles, and its width at the widest part equal to that of 2·5 to 3 red corpuscles. A round nucleus or vacuole was readily discernible in the protoplasm of the dilated portion of the organism. The body remained almost motionless, whilst the long flagellum was twisted and twirled, lashing the corpuscles to right and left. At a later period the undulating membrane became very distinct.

Cow No. I.—On November 7th 1892, June 15th, July 3rd, September 2nd, 1893, a single example of the hæmatozoon similar to the one found in the blood of Bull I was observed. Two guinea-pigs inoculated with the blood in June died in seven and nine days respectively, but no large hæmatozoa were discovered in their blood, although the small variety of organisms were swarming.

Bull No. III.—This animal, on September 26th, 1893, the 56th day of Intermission III, developed rinderpest spontaneously. Death followed on the 28th September. Two guinea-pigs inoculated on 21st September, 1892, with 0·3 c.cm. of blood in which no hæmatozoa could be discovered microscopically, contracted Surra after a latent period of 14 days.

Bull No. IV.—This animal, on the 29th January 1894, the 195th day of Intermission III, met with an accident, which necessitated its being destroyed. Two guinea-pigs inoculated on 21st September 1892 with blood from this animal, in which no hæmatozoa could be discovered, failed to contract the disease.

Calf No. I.—This animal, on 28th September 1893, the 98th day of Intermission III, developed rinderpest spontaneously, and death followed on the 30th September.

PHYSIOLOGICAL AND PATHOLOGICAL PROBLEMS IN BOVINES AND BUFFALOES DURING A PERIOD OF OBSERVATION AND THE PHASES OF SURRA.

Up to the time these experiments were undertaken there was no evidence forthcoming to show whether buffaloes are susceptible to the organism of Surra or not, although it was surmised that, if bovines were capable of contracting the disease, buffaloes would not be exempt. We had previously shown that bovines passed through an attack of Surra, and if uncomplicated with any other disease the animals always survived, even when re-inoculation was resorted to after varying periods.

In our previous researches the experiments were conducted either in the plains or at an altitude of 1,850 feet; consequently, when these investigations were initiated on buffaloes in the hills at a height of 7,500 feet, it was decided to ascertain concurrently what effect, if any, was produced on bovines by the change of elevation, temperature, etc.

The opportunity was also taken of working out certain physiological and pathological problems, as far as circumstances would permit, on very much the same lines as those adopted in the case of equines, a précis of which were included in the Report for 1895-96. In order to make this enquiry in bovines and buffaloes, the quantity and composition of the *ingesta* and *egesta* have been ascertained during a period of observation, previous to inoculation, the incubatory period of the disease, and the paroxysms and intermissions until death.

The following data were recorded, *viz.*, the weight and composition of the *ingesta*, including fodder and water; also that of the *egesta*, including dung and urine.

In the Urine the total Nitrogen, the Urea, the Hippuric Acid and Ammonia were separately estimated.

UNTREATED CASES OF SURRA.

Bull V.

A hill animal, aged two years, height 10 hands, in good health and condition. After a period of observation lasting 72 days, the animal, on January the 14th, 1897, was inoculated on the ear by means of a slight scratch, and a trace of blood containing a few hæmatozoa—taken from Buffalo No. I, primarily inoculated from a horse—was smeared over the wound. As no symptoms of Surra supervened up to the 22nd of February 1897, the animal was re-inoculated on that date in the ear with blood taken from Buffalo II.

It is of interest to note that swelling was absent from the seat of inoculation, although the hæmatozoon appeared in the blood on the 8th day following the operation.

The period of incubation lasted 6·75 days. At the time of writing this note 131 days have elapsed since the first appearance of the organism in the blood.

The first paroxysm extended over three days, on the last of which the hæmatozoon was swarming. Intermission I lasted three days and was followed by Paroxysm II, during which period the hæmatozoon was found to be swarming for a period of 48 hours. Intermission II extended over five days and was followed by a third paroxysm lasting 24 hours.

One hæmatozoon, however, was only found in two covered glass preparations of fresh blood. From the 17th of March till July 25th no more organisms have been observed.

Body-weight —The animal was weighed three times daily—morning, noon and evening. During the period of observation the body-weight varied between a maximum of 292 and minimum 252lb. The variation in weight was of course due to the different amounts of food and moisture in the stomach and intestines at the time of weighing, but the mean for the full period of observation was 276lb. The animal after inoculation rapidly lost flesh, and on the seventh day of the last intermission weighed 226lb.

On reference to the case of Bull I in Volume I of Surra Report, it will be noted that this animal rapidly lost flesh during the attack of the disease, and that it did not become fat and sleek again until the expiration of 12 months from the date of inoculation.

Water drunk.—During the period of observation 6·55 litres were taken daily. The amount rapidly decreased through the rest of the case, being most marked during the period of incubation of the disease. During the paroxysms 4·82 and intermissions 4·98 litres were respectively drunk. For the whole period of 101 days it averaged 5·07 litres or 11·15lb.

Water in food.—In addition to the above 0·608 litres (1·34lb) were taken in daily as moisture in the fodder, equal to a total of 5 68 litres (12·49lb.)

The ratio of water egested to ingested was in the period of observation 1 : 1·28; it decreased in the latent period to 1 : 1·03, whilst during the paroxysms and intermissions the ratios were 1 : 1·35 and 1 : 1·22, respectively. For the whole period of 101 days it was the same as during the intermissions.

During the period of observation lasting 72 days the animal drank 4·18lb of water for every 1lb of body-weight, whereas during the third intermission, lasting seven days, the quantity had become reduced to 0·325lb for each pound body-weight.

Food.—This consisted of hay which was given to the animal *ad libitum*. The animal weighed at the commencement 287lb and at the end of the third intermission (seven days), 101 days later, 226lb, showing a loss in body-weight of 61lb equal to 21·25 per cent.

The difference between the Nitrogen ingested in the food and egested in the urine, dung, etc., during the same period amounted to 10·75 per cent. of the total loss calculated as proteid matter; the remaining loss was due to moisture, Co.$_2$, etc.

Urine.—The mean daily quantity of urine voided in the observation period was 683 c.c.; it decreased slightly during the latent period, 641 c.c. In the paroxysms and intermissions there was a decrease of 29 per cent. compared with the observation period. During the whole case (101 days), a daily average of 569 cc. was passed.

The maximum daily output during paroxysms was 775 c.c. and minimum 330 c.c.; in the intermissions it was 780 c.c., 260 c.c., respectively.

Urea.—The mean excretion of Urea in the observation period was 2·86 grammes with a maximum of 5·07 grammes and minimum of 0·87 grammes. It increased slightly in the latent period, 2·96 grammes, but there was a considerable increase during paroxysms and intermissions, *viz.*, 4·03 and 3·66 grammes respectively. The maxima being 9·24 grammes, 8·58 grammes, the minima being 2·31 grammes, 1·56 grammes, for paroxysms and intermissions, respectively. The mean daily Urea excreted during the 101 days, the animal was under observation, was 3·07 grammes.

Hippuric Acid.—In the period of observation extending over 72 days a mean average quantity of 32·23 grammes was excreted daily. During the latent period there was a decrease amounting to 30 per cent., whilst in Paroxysm I and Intermission I the decrease was 27 per cent., and 13 per cent. respectively. From the latter period there was a gradual diminution in the amount of Hippuric Acid passed, *viz.*, 58 per cent. at the end of Intermission III.

The following were the mean daily averages for different periods :—

	Grammes.
Observation	32·23
Latent Period	21·87
Paroxysms	21·76
Intermissions	18·12
Whole Period	28·69

Albumen.—No Albumen appeared in the urine during the whole case.

Total Solids in the Urine.—The mean daily output during 101 days was 59·09 grammes. The maximum mean daily quantity of the different periods, 72·96 grammes, was passed in the observation period, whilst the minimum mean daily quantity, 45·49 grammes, was passed during Intermission III.

The total solids consisted chiefly of carbonate of lime in suspension in the Urine, and Hippuric Acid, Urea and Mucin, etc., in solution. During the course of the disease there was a gradual falling off in the amount of total solids in the urine—from 72·96 grammes in the observation period to 45·49 grammes in Intermission III.

The ratio of the total solids in the different periods was :—

	Grammes.
Observation	1
Latent Period	0·82
Paroxysms	0·72
Intermissions	0·70
Whole Period	0·81

Dung.—The average quantity passed throughout the whole case of 101 days was 5·116 kilos (11·25lb). The mean daily averages in the different periods were as follows :—

	lb
Observation	14·14
Latent Period	9·90
Paroxysms	9·57
Intermissions	11·37
Whole Period	11·25

Temperature of the Air.—This investigation was carried on during December 1896 and April 1897 inclusive. The maximum and minimum temperatures in the shade (south verandah) during the whole case were 82° and 32° respectively.

TABLE VIII.

Bull V.

Showing the weight of animal, grass eaten, water drunk and dung passed during a preliminary period of observation and the phases of Surra.

Periods.	No. of days.	Weight of animal.			Grass eaten.				Water drunk.				Dung passed.			
		12 noon.	5 P.M.	8 A.M.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.
		lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb
Observation	16	284	286	287	42·00	52·00	42·25	136·25	57·00	41·00	48·50	146·50	108·50	41·75	56·50	206·75
,,	56	268	269	268	142·25	158·50	163·25	464·00	481·25	187·50	223·50	892·25	252·25	269·75	290·25	812·25
Full Observation	72	276	277	277	184·25	210·50	205·50	600·25	538·25	228·50	272·00	1,038·75	360·75	311·50	346·75	1,019·00
Latent Period	6	246	249	247	12·00	11·25	12·75	36·00	34·75	0·00	17·00	51·75	11·50	21·25	26·75	59·50
Paroxysm I	3	240	240	237	6·25	4·25	4·75	15·25	16·00	3·00	13·25	32·25	5·00	8·75	10·25	24·00
Intermission I	3	239	241	239	6·00	6·25	7.25	19·50	8·00	13·00	8·00	29·00	7·00	9·75	18·50	35·25
Paroxysm II	4	235	236	234	8·25	8·75	8·50	25·50	18·00	11·00	18·25	47·25	5·25	11·25	24·50	41·00
Intermission II	5	238	239	236	12·00	8·50	11·00	31·50	24·25	13·00	28·50	65·75	8·50	14·50	26·50	49·50
Paroxysm III	1	237	239	236	1·75	2·50	0·50	4·75	0·00	6·50	2·75	9·25	1·50	2·50	6·50	10·50
Intermission III	7	232	233	232	16·25	15·25	14·00	45·50	50·25	16·50	4·00	70·75	15·75	21·00	50·50	87·25

2nd November 1897. Seven months after last observation recorded—animal weighed 316lb.

TABLE IX.

Bull V.

Showing the weight of animal, grass eaten, water drunk and dung passed for the massed periods.

Periods.	No. of days.	Weight of animal.			Grass eaten.				Water drunk.				Dung passed.			
		12 noon.	5 P. M.	8 A. M.	12 noon.	5 P. M.	8 A. M.	Total.	12 noon.	5 P. M.	8 A. M.	Total.	12 noon.	5 P. M.	8 A. M.	Total.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Observation . .	72	276	277	277	184·25	210·50	205·50	600·25	538·25	228·50	272·00	1038·75	360·75	311·50	346·75	1,019·00
Latent Period . .	6	246	249	247	12·00	11·25	12·75	36·00	34·75	30·00	17·00	51·75	11·50	21·25	26·75	59·50
Paroxysms . .	8	237	238	236	16·25	15·50	13·75	45·50	34·00	20·50	34·25	88·75	11·75	22·50	41·25	75·50
Intermissions . .	15	236	238	236	34·25	30·00	32·25	96·50	82·50	42·50	40·50	165·50	31·25	45·25	95·50	172·00
Whole Period . .	101	249	250	249	246·75	267·25	264·25	778·25	689·50	291·50	363·75	1,344·75	415·25	400·50	510·25	1,326·00
Percentage . .	...	...	...	...	31·70	34·34	33·95	...	51·27	21·67	27·04	...	31·31	30·20	38·48	...

TABLE X.

Bull V.

Showing the quantity of the constituents of the Urine during a preliminary period of observation, and the phases of Surra.

Periods.	No. of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Observation . . .	16	41·86	389·11	53·868	19·525	30·342	4·126
„ . . .	56	164·06	1,931·41	262·163	76·429	150·614	35·099
Latent period . . .	6	17·78	131·20	22·326	8·293	10·232	3·800
Paroxysm I . . .	3	9·58	70·80	11·128	4·459	5·521	1·137
Intermission I . . .	3	14·52	83·63	17·361	6·773	6·522	4·065
Paroxysm II . . .	4	19·18	86·44	16·998	8·947	6·740	1·308
Intermission II . .	5	17·57	93·30	17·370	8·196	7·275	1·898
Paroxysm III . . .	1	3·47	16·81	4·928	1·619	1·311	1·998
Intermission III . . .	7	22·75	94·96	26·071	10·612	7·403	8·053

TABLE XI.

Bull V.

Showing the quantity of the constituents of the Urine for the massed periods.

Periods.	No. of days.		Hippuric Acid	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Observation . . .	72	205·92	2,320·52	316·031	95·954	180·956	39·2
Latent Period . .	6	17·78	131·20	22·326	8·293	10·232	3·800
Paroxysms . . .	8	32·23	174·05	33·054	15·025	13·572	4·448
Intermissions . . .	15	54·84	271·89	60·802	25·581	21·200	14·016
Whole Period . . .	101	310·77	2,897·66	432·213	144·853	225·960	61·484

TABLE XII.

Bull V.

Showing the mean daily quantity of the constituents of the Urine during a preliminary period of observation, and the phases of Surra.

Periods.	No. of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Observation . . .	16	2·61	24·32	3·367	1·220	1·896	0·258
„ . . .	56	2·93	34·49	4·681	1·364	2·689	0·628
Latent Period . . .	6	2·96	21·87	3·721	1·382	1·705	0·633
Paroxysm I . . .	3	3·19	23·60	3·709	1·486	1·840	0·379
Intermission I . . .	3	4·84	27·88	5·787	2·258	2·174	1·355
Paroxysm II . . .	4	4·79	21·61	4·249	2·237	1·685	0·327
Intermission II . .	5	3·51	18·66	3·474	1·639	1·455	0·379
Paroxysm III . . .	1	3·47	16·81	4·928	1·619	1·311	1·998
Intermission III . .	7	3·25	13·56	3·724	1·516	1·058	1·150

TABLE XIII.

Bull V.

Showing the mean daily quantity of the constituents of the Urine for the massed periods.

Periods.	No. of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Observation . . .	72	2·86	32·23	4·389	1·332	2·513	0·545
Latent Period . . .	6	2·96	21·87	3·721	1·382	1·705	0·633
Paroxysms . . .	8	4·03	21·76	4·132	1·878	1·696	0·555
Intermissions . . .	15	3·66	18·12	4·053	1·705	1·413	0·934
Whole Period . . .	101	3·07	28·69	4·279	1·434	2·237	0·608

TABLE XIV.

BULL V.

Showing the mean daily averages, with percentages and ratios in a preliminary period of observation and the phases of Surra, of the Urine and its constituents, together with the water drunk and dung passed.

Periods.		Observation.	Latent Period.	Paroxysm I.	Intermission I.	Paroxysm II.	Intermission II.	Paroxysm III.	Intermission III.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Perod.
Days.		72	6	3	8	4	5	1	7	72	6	8	15	101
Urine	Quantity. C C.	683	641	383	533	619	376	440	508	683	641	480	472	569
Ratio	...	1	0·94	0·56	0·79	0·90	0·55	0·64	0·74	1	0·94	0·70	0·69	0·83
Urea	Grammes	2·86	2·96	3·19	4·84	4·79	3·51	3·47	3·25	2·86	2·96	4·03	3·66	3·07
Ratio	...	1	1·03	1·11	1·69	1·67	1·22	1·21	1·13	1	1·03	1·33	1·35	1·18
Hippuric Acid	Grammes	32·23	21·87	23·60	27·88	21·61	18·66	16·81	13·56	32·23	21·87	21·76	18·12	28·69
Ratio	...	1	0·68	0·73	0·86	0·67	0·58	0·52	0·42	1	0·68	0·64	0·62	0·73
Albumen	Grammes	...	...	...	...	...	...	...	...	...	...	...	...	...
Total Solids	Ditto	72·96	60·02	50·90	62·37	57·59	45·88	47·96	45·49	72·96	60·02	52·15	51·25	59·09
Ratio	...	1	0·82	0·69	0·85	0·79	0·63	0·65	0·62	1	0·82	0·71	0·70	0·81
Water drunk	Litres	6·55	3·92	4·88	4·39	5·37	5·97	4·20	4·59	6·55	3·92	4·82	4·98	5·07
Ratio	...	1	0·59	0·74	0·67	0·82	0·91	0·64	0·70	1	0·59	0·73	0·76	0·77
Ratio Urea / Urine	1:	239	217	120	110	129	107	127	156	239	217	125	124	176
Ratio Urine / Water drunk	1:	9·59	6·11	12·74	8·23	8·67	15·89	9·54	9·03	9·59	6·11	10·32	11·05	9·27
Ratio Water egested / „ ingested	1:	1·28	1·03	1·62	1·02	1·36	1·64	1·08	1·01	1·28	1·03	1·35	1·22	1·22
Dung passed	Kilos	6·433	4·507	3·636	5·341	4·659	4·500	4·773	5·665	6·433	4·507	4·356	5·169	5·116
Ratio	...	1	0·70	0·56	0·83	0·72	0·69	0·74	0·88	1	0·70	0·67	0·80	0·79

TABLE XV.

Bull V.

Showing the total amount of Nitrogen, ingested and egested, during a preliminary period of observation, and the phases of Surra.

Periods.	Days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen	In urine.	In dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	72	1,135·018	262·163	926·363	1,188·526	...	53·508	123·6
Latent Period .	6	68·072	22·326	54·090	76·416	...	8·344	112·2
Paroxysm I .	3	28·836	11·128	21·818	32·946	...	4·110	108·6
Intermission I .	3	36·872	17·361	32·045	49·406	...	12·534	108·6
Paroxysm II .	4	48·218	16·998	37·272	54·270	...	6·052	106·8
Intermission II .	5	59·563	17·370	45·000	62·370	...	2·807	108·1
Paroxysm III .	1	8·981	4·928	9·545	14·473	...	5·492	107·7
Intermission III .	7	86·036	26·071	79·318	105·389	...	19·353	105·4

TABLE XVI.

Bull V.

Showing the total amount of Nitrogen ingested and egested in the massed periods.

Periods.	Days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In urine.	In dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	72	1,135·018	262·163	926·363	1,188·526	...	53·508	123·6
Latent Period .	6	68·072	22·326	54·090	76·416	...	8·344	112·2
Paroxysms . .	8	86·035	33·054	68·635	101·689	...	15·654	107·7
Intermissions .	15	182·471	60·802	156·363	217·165	...	34·694	107·4
Whole Period .	101	1,471·596	378·345	1,205·451	1,583·796	...	112·200	110·1

TABLE XvII.

Bull V.

Showing the mean daily amount of Nitrogen ingested and egested, during a preliminary period of observation, and the phases of Surra.

Periods.	Days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In urine.	In dung.	Total.	+	−	
		Grammes	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	72	15·764	3·641	12·866	16·507	...	0·743	123·6
Latent Period .	6	11·345	3·721	9·015	12·736	...	1·391	112·2
Paroxysm I .	3	9·612	3·709	7·273	10·982	...	1·370	108·6
Intermission I .	3	12·291	5·787	10·682	16·469	...	4·178	10·86
Paroxysm II .	4	12·054	4·249	9·318	13·567	...	1·513	106·8
Intermission II .		11·913	3·474	9·000	12·474	...	0·561	108·1
Paroxysm III .	1	8·981	4·928	9·545	14·473	...	5·492	107·7
Intermission III .	7	12·291	3·724	11·331	15·055	...	2·764	105·4

TABLE XVIII.

Bull V.

Showing the mean daily amount of Nitrogen, ingested and egested in the massed periods.

Periods.	Days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In urine.	In dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	72	15·764	3·641	12·866	16·507	...	0·743	123·6
Latent Period .	6	11·345	3·721	9·015	12·736	...	1·391	112·2
Paroxysms . .	8	10·754	4·132	8·579	12·711	...	1·957	107·7
Intermissions .	15	12·165	4·053	10·424	14·477	...	2·312	107·4
Whole Period .	101	14 570	3·746	11·935	15·681	...	1·111	110·1

1,483·89 grammes Nitrogen in Hay.
56·45 „ „ „ Barley.

1,540·34 „ „ „ Food.
1,205·00 „ „ „ Dung.

335·34 „ „ „ Assimilated.

436·15 grammes Nitrogen in Urine.
335·34 „ „ Assimilated.

100·81 „ „ Actually lost as flesh.
29·57 ratio of N. per cent. in flesh.

2,980·95 grammes.
·0022

6·558090 lbs. flesh lost by Nitrogen.

Total loss in Body-weight . . . { lbs. 287 at commencement. 226 — 61 lbs. loss.

Loss by Nitrogen = 10·75 per cent.
„ „ Co_2, moisture, etc., = 89·25 per cent.

TABLE XIX.

Bull V.

Showing the amount of water ingested and egested, and the percentage excreted in Urine and Dung.

Periods.	No. of days.	Water in grass.	Water drunk.	Total Ingested.	Water in urine.	Water in dung.	Total Egested	Difference between Ingested and Egested.	% Ingested water excreted as urine.	% Excreted in dung.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.			
Preliminary Observation .	72	52,679	472,159	524,838	43,984	362,393	400,377	+118,461	...	...
Mean daily . . .	...	731	6,557	7,289	611	5,033	5,644	1,645	8·38	69·06
Latent period . .	6	1,755	23,522	25,277	3,485	20,982	24,467	+810	...	...
Mean daily . . .	...	292	3,920	4,212	581	3,497	4,078	135	13·79	83·02
Paroxysm I . .	3	744	14,659	15,403	997	8,463	9,460	+5,943	...	...
Mean daily . . .	...	248	4,886	5,134	332	2,821	3,153	1,981	6·46	54·94
Intermission I . .	3	951	13,181	14,132	1,413	12,430	13,843	+289	...	...
Mean daily . . .	...	317	4,393	4,710	471	4,143	4,614	96	10·00	87·96
Paroxysm II . .	4	1,243	21,477	22,720	2,245	14,458	16,703	+6,017	...	...
Mean daily . . .	...	311	5,369	5,680	561	3,614	4,175	1,504	9·87	63·62
Intermission II . .	5	1,536	29,886	31,422	1,651	17,455	19,106	+12,316	...	...
Mean daily . . .	...	307	5,977	6,284	330	3,491	3,821	2,463	5·25	55·55
Paroxysm III . .	1	231	4,204	4,435	392	3,702	4,094	+341	...	...
Mean daily . . .	...	231	4,204	4,435	392	3,702	4,094	341	8 83	8·347
Intermission III . .	7	2,219	32,159	34,378	3,237	30,767	34,004	+374	...	...
Mean daily . . .	...	317	4,594	4,911	462	4,395	4,857	53	9·40	89·4

TABLE XX.

Bull V.

Showing the percentages of Ingested water excreted as Urine, in the Dung and by the Lungs and Skin.

Periods.	Length of days.	Urine %.	In dung %.	Lungs sweat, etc.	Total.
Preliminary Observation . . .	72	8·38	69·06	22·56	100
Latent Period	6	13·79	83·02	3·19	100
Paroxysm I	3	6·46	54·94	38·60	100
Intermission I	3	10·00	87·96	2·04	100
Paroxysm II	4	9·87	63·62	25·51	100
Intermission II	5	5·25	55·55	38·20	100
Paroxysm III	1	8·83	83·47	7·70	100
Intermission III	7	9·40	89·49	1·11	100

TABLE XXI.

Bull V.

Showing the Percentage of Dry matter digested during a preliminary period of observation and the phases of Surra.

Periods.		Total dry matter ingested.	:	100	: :	Total dry matter digested.	:	% Dry matter digested in different periods.
		lbs.				lbs.		
Preliminary Observation . . .	As.	484·16	:	100	: :	293·91	:	60·70
Latent Period .	,,	30·07	:	100	: :	19·04	:	63·31
Paroxysm I . .	,,	13·74	:	100	: :	8·36	:	60·84
Intermission I . .	,,	17·57	:	100	: :	9·67	:	55·03
Paroxysm II . .	,,	23·25	:	100	: :	14·05	:	60·43
IntermissionII . .	,,	28·72	:	100	: :	17·62	:	61·35
Paroxysm III . .	,,	4·33	:	100	: :	1·97	:	45·49
Intermission III .	,,	40·99	:	100	: :	21·43	:	52·28

TABLE XXII

Bull V.

Showing the Percentages as above, during massed Periods.

Periods.		Total dry matter ingested.	:	100	: :	Total dry matter digested.	:	% Dry matter digested in different periods.
Observation . .	As.	484·16	:	100	: :	293·91	:	60·70
Latent Period . .	,,	30·07	:	100	: :	19·04	:	63·31
. . .	,,	41·32	:	100	: :	24·38	:	59·00
Intermission . .	,,	87·28	:	100	: :	48·72	:	35·8
Whole Period .	,,	642·83	:	100	: :	386·05	:	60·05

	lbs.	
Total hay eaten	= 778·25	
Less H_2O	= 135·42	
	642·83	Total dry mater ingested.
Total Dung	=1,326·00	
Less H_2O	=1,069·22	
	256·78	Dry Dung.
Total dry matter ingested . . .	= 642·83	
Total ,, egested . . .	= 256·78	
Dry matter digested .	= 386·05	

As 642·83 100 : : 386·05 : 60·05 % dry matter digested for whole period.

TABLE XXIII.

Bull V.

Showing the mean daily number of the different blood corpuscles in I.C.M.M. with the ratios to one another together with the percentage of Hæmoglobin during periods of observation and disease (Surra).

Periods.	Hæmatozoa. Maximum.	Hæmatozoa. Minimum	Hæmoglobin.	Red. Corpuscles. in 1 C. m. m.	White. Corpuscles. in 1 C. m. m.	Coarsely-granular Corpuscles. in 1 C. m. m.	Hæmatozoa in 1 C. m. m.	Ratio. W. C. to R. C.	Ratio. C. G. C. to W.	Ratio. C.C.G. to R.C.	No. of days.
Observation .	...	...	100	8,419,444	15,783	3,791	...	1 : 533	1 : 4·2	1 : 2,221	72
Latent Period .	...	...	102	9,001,666	19,466	5,500	...	1 : 462	1 : 3·5	1 : 1,636	6
Paroxysm I .	S.	F.	96	8,956,666	15,166	4,833	15,00	1 : 590	1 : 3·1	1 : 1,853	3
Intermission I	...	...	93	8,440,000	10,666	3,000	...	1 : 791	1 : 3·5	1 : 2,813	3
Paroxysm II .	S.	F.	85	8,122,500	20,750	3,625	12,500	1 : 391	1 : 5·7	1 : 2,240	4
Intermission II	...	...	77	7,038,000	14,300	4,900	...	1 : 492	1 : 2·9	1 ; 1,436	5
Paroxysm III .	F.	F.	74	6,850,000	15,500	6,000	50	1 : 442	1 : 2·6	1 : 1,141	1
Intermission III	...	...	82	7,988,571	17,714	5,571	...	1 : 451	1 : 3·2	1 : 1,434	7

TABLE XXIV.

Bull V.

Showing the mean for Observation, Latent Period, Paroxysms, Intermissions and for the whole Period.

Periods.	Hæmoglobin.	Red. corpuscles. in 1 C. m. m.	White Corpuscles. in 1 C. m. m.	Coarsely. Granular, corpuscles. in 1 C. m. m.	Hæmatozoa in 1 C. m. m.	Ratio. W. C. to R.C.	Ratio G. C. to W.	Ratio. C.C. G. C. to R.	No. of days. C.
Observation . .	100	8,419,444	15,783	3,791	...	1 : 533	1 : 4·2	2,221	72
Latent Period .	102	9,001,666	19.466	5,500	...	1 : 462	1 : 3·5	1 : 1,636	6
Paroxysms . .	85	7,976,389	17,139	4,819	5,640	1 465	1 : 3·5	1 : 1,655	8
Intermissions . .	84	7,822,190	14,227	4,490	...	1 : 549	1 : 3·1	1 : 1,742	15
Whole Period .	93	8,304,922	16,654	4,650	...	1 : 498	1 : 3·6	1 : 1,786	101

TABLE XXV.

Bull V.

Showing the percentage of Corpuscles in the massed periods, taking the number in the Observations as 100.

Periods.	Hæmoglobin.	Red. corpuscles. in 1 C. m. m.	White. corpuscles. in 1 C. m. m.	Coarsely, granular, Corpuscles. in 1 C. m. m.
Observation .	100	100	100	100
Latent Period .	102	106·2	123·3	145·6
Paroxysms .	85	94·7	108·5	127·1
Intermissions .	84	92·9	90·1	118·4
Whole Period .	93	98·6	105·5	122·6

BULL V.

Corpuscular changes in the Blood.

Red Corpuscles.—Taking the mean daily number during the period of observation as 100, there was an increase of 6·2 per cent. in the latent period. These numbers decreased 5·3 per cent. and 7·1 per cent. in the paroxysms and intermissions, respectively. For the whole period the fall was 1·4 per cent.

White Corpuscles.—The rise in their numbers during the latent period was equivalent to a mean of 23·3 per cent. During the paroxysms these were 8·5 per cent. higher than that of observation period, but fell nearly 9·9 per cent during the intermissions. For the whole case the rise was 5·5 per cent.

Coarsely granular oxyhile cells.—The maximum increase in their number, 45·6 per cent., occurred during the latent period, and during paroxysms and intermissions the rise was 27·1 per cent. and 18·4 per cent., respectively, while for the whole period of 101 days it was 22·6 per cent.

Hæmoglobin.—During the latent period 2 per cent. hæmoglobin increased above that found during the observation period, but in the paroxysms and intermissions there was a fall of 15 per cent. and 16 per cent., respectively. For the whole period there was a decrease of nearly 7 per cent.

BUFFALO I.

The following is a brief account obtained from the ingesta and egesta of a Buffalo (male) aged three years, which was inoculated with three drops of blood derived from a pony suffering from Surra.

The period of observation lasted for 14 days.

Body-weight.—The animal was weighed three times a day, *viz.*, at 8 A.M., noon and 5 P.M. It will be noticed that this animal, unlike Buffalo II, lost little in weight during the period of observation, though there were differences of 8 to 10lbs. in the intervals between weighings.

On first weighing, the animal registered 359lbs., and 14 days later 357. The mean weight for this period is 360lbs. It is of interest to note that the animal increased in weight for some days during the period of observation.

After inoculation there was a gradual loss, until at death the body weighed 267lbs.

At the *post-mortem* the intestines were found to contain 64lbs. of dung, which represented in health 17·77 per cent. and at death 23·97 per cent. of the body-weight. No visible adipose tissue was found under the skin.

Water drunk.—The average daily quantity of water drunk during the period of observation was 5·47 litres; it slightly increased in the latent period (5·90) and reached a maximum of 9·54 litres during Intermission III. After this the average quantity gradually reduced, until, in Paroxysm XII, it was only 3·97 litres. The mean for paroxysms and intermissions was 6·54 and 7·03 litres, respectively. For the whole period the average daily quantity was 6·23 litres.

Water in food.—In addition to the above ·839 kilos were taken in daily in the fooder, equal to a total of 7·12 kilos (15·66lbs.) ingested. The ratio of water egested to ingested was in the observation 1 : 1·15; it increased in the latent period to 1 : 1·28, whilst in paroxysms and intermissions it was 1 : 1·00 and 1 : 1·06, respectively. For the whole period of 139 days it was 1 : 1·12.

Food.—The animal was kept on hay only. The ration contained a daily average of ·416 per cent. Nitrogen. During the whole case the animal ingested 2581·04 grammes of Nitrogen and egested in dung 2,160·84 grammes, giving 420·20 grammes as assimilated Nitrogen. The total Nitrogen excreted in urine during the same period was 860·278 grammes. Deducting the amount of assimilated Nitrogen from this, 440·078 grammes are left, which represent the actual Nitrogen lost. Converting this Nitrogen to its equivalent as flesh, we obtain a loss of 18·659 kilos (41·05 lbs).

The total decrease in body-weight during the whole period was 41·81 kilos (92lbs) so that the loss by Nitrogen was equivalent to 44·62 per cent., the remaining 55·38 per cent. being due to CO_2 moisture, etc. No adipose tissue was observed at the *post mortem.*

Urine.—In the period of observation the average quantity passed was 1,250 cc. which decreased in the latent period to 987 cc. In the paroxysms and intermissions, it averaged 982 and 912 c.c., respectively. During the whole case the average quantity passed was 1,004 cc. The maximum quantity 1,900 cc. was passed in Paroxysm II, and throughout the whole case it varied from that amount to as little as 610 cc. in Intermission X. The specific gravity varied from 1,066 to 1,010 and the Urine taken from the bladder at *post-mortem* was 1,040 c,c. containing no Hippuric Acid and only 1·35 per cent. of solids including 0·62 per cent. of Urea.

Urea.—The average daily quantity of Urea passed by this animal was very small in the observation and latent periods being 2·98 and 2·21 grammes respectively. In the paroxysms it was highest, *viz.*, 5·74 grammes, and again fell to 4·33 grammes in the intermissions. For the whole period the average quantity was 4·87 grammes. The maximum amounts 37·97 grammes being passed on the day of death and the minimum 0·73 grammes in Paroxysm III. It is worth while to note that the amount of Urea passed daily 4 increased to much more than the average, 10 days previous to the death of the animal.

Ratio of Urea to Urine.—During the period of observation the average ratio was 1 : 419, in the latent period 1 : 446, in paroxysms 1 : 171, and for the intermissions 1 : 210 while for the whole period it was 1 : 206.

Hippuric Acid.—In the observation period the animal passed 53·84 grammes which fell in the latent period to 52·37 grammes. In the paroxysms and intermissions the amounts were 42·64 and 43·88 grammes, respectively; the former period lasting 39 and the latter 81 days.

The mean for the whole period of 139 days was 44·90 grammes. The maximum daily quantity, 54·86 grammes, was passed in Intermission I.

Of the total Nitrogen in the Urine during the different periods the following table show me percentage excreted.

TABLE XXVI.

Periods.	Urea per cent.	Hippuric Acid per cent.	$N.H_3$ etc. per cent.	Total.
Observation . .	23·73	71·61	4·66	100
Latent Period . .	19·45	77·06	3·04	„
Paroxysms . .	39·65	49.10	11·25	„
Intermissions . .	29·67	57 85	12·03	„
Whole Period . .	31·74	57·17	10·86	„

Albumen.—There was no albumen in the Urine during the whole case.

Total solids (in Urine).—In the whole case the average daily output was 101·87 grammes an the observation period it was 140·69 grammes, in the latent period and paroxysms the amount being nearly identical, *viz.*, 101.92 and 101·64 grammes, respectively, while in the intermissions it fell to 97·31 grammes.

The largest amount being passed in the observation period and the smallest, *i.e.*, 56·11 grammes was passed in Paroxysm IV.

The ratio of the total solids in the different periods was :—

Observation	1·0
Latent Period	0·72
Paroxysms	0·72
Intermissions	0·69
Whole Period	0·72

Dung.—The average quantity of dung passed throughout the whole case was 7·76 kilos (17·07 lbs.) containing on the average 83·51 per cent. of water and 0·257 per cent. of Nitrogen.

In the observation period the amount was 6·20 kilos (13·64lbs.), in latent period 5·75 kilos (12·65 lbs.), in paroxysms 7·95 kilos (18·02 lbs.) and in the intermissions 7·89 kilos (17·35 lbs.).

At autopsy the total amount of dung found in the intestines was 64 lbs. (29·09 kilos).
The ratio of dung was :—

Observation	1·0
Latent Period	0·92
Paroxysms	1·28
Intermissions	1·27
Whole Period	1·25

TABLE XXVII.

Buffalo I.

Showing the Weight of Animal, Grass eaten, Water drunk and Dung passed during a preliminary period of observation and the phases of Surra.

Periods.	No. of days.	Weight of animal.			Grass eaten.				Water drunk.				Dung passed.			
		12 noon.	5 P.M.	8 A.M.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Observation	14	353	363	359	...	...	...	209·50	130·00	10·50	28·00	168·50	...	...	...	191·00
Latent period	5	357	361	356	...	...	...	56·50	17·25	24·00	23·75	65·00	...	...	...	63·25
Paroxysm I	3	354	357	358	...	...	...	29·50	25·00	7·00	8·00	40·00	...	...	...	63·00
Intermission I	3	357	358	354	7·00	11·50	10·50	29·00	12·00	6·00	21·50	39·50	13·50	30·25	13·50	57·25
Paroxysm II	6	351	354	352	16·50	17·50	21·50	55·50	20·25	18·00	32·00	70·25	29·75	68·00	32·00	129·75
Intermission II	5	347	350	349	9·25	20·00	17·50	46·75	20·00	15·00	24.00	59·00	26·50	53·50	11·50	91·50
Paroxysm III	2	341	347	350	5·25	8·00	4·00	17·25	30·00	0·00	0·00	30·00	11·00	18·00	6·00	35·00
Intermission III	8	353	355	354	35·50	29·50	26·50	91·50	105·00	28·00	35·00	168·00	55·50	71·50	35·00	162·00
Paroxysm IV	4	349	353	355	17·00	17·00	15·00	49·00	33·00	16·00	15·00	63·00	28·00	25·00	33·00	86·00
Intermission IV	6	342	344	342	20·50	27·00	18·00	65·50	18·00	21·50	47·50	87·00	24·00	26·00	64·50	114·50
Paroxysm V	2	357	348	366	6·00	6·00	4·50	16·50	13·00	17·00	5·00	35·00	4·50	4·50	21·00	30·00
Intermission V	5	343	346	349	14·50	14·75	15·50	44·75	27·00	0·00	32·50	59·50	11·75	19·50	40·00	71·25
Paroxysm VI	3	339	338	341	6·00	12·00	6·50	24·50	0·00	25·50	17·50	43·00	20·00	11·00	31·00	62·00
Intermission VI	6	329	330	331	16·50	16·50	19·50	54·50	31·50	20·50	38·50	90·50	30·50	42·50	32·00	105·00
Paroxysm VII	2	330	335	333	5·00	6·50	5·00	16·50	17·00	0·00	11·50	28·50	9·00	20·00	6·50	35·50
Intermission VII	14	328	327	328	44·75	48·50	49·50	142·75	170·00	37·00	52·50	259·50	106·00	82·00	106·00	294·00
Paroxysm VIII	4	327	331	328	16·00	16·00	13·00	45·00	42·75	4·50	22·50	69·75	38·50	21·00	25·00	84·50
Intermission VIII	9	314	321	317	22·75	21·00	18·75	62·50	100·00	22·00	17·00	139·00	27·00	26·50	63·00	116·50
Paroxysm IX	2	319	318	321	4·75	6·50	4·50	15·75	28·00	6·00	0·00	34·00	7·00	6·00	19·50	32·50
Intermission IX	14	312	314	314	45·75	40·75	38·25	124·75	164·25	20·00	23·50	227·75	50·25	57·75	109·75	217·75
Paroxysm X	3	299	298	298	8·25	8·50	8·50	25·25	23·50	0·00	15·00	38·50	7·50	10·75	21·00	38·75
Intermission X	7	302	304	302	18·00	18·50	17·00	53·50	32·00	47·00	26·50	105·50	16·25	25·00	68·25	109·50
Paroxysm XI	5	293	298	294	15·00	12·75	12·25	40·00	48·00	16·50	10·50	75·00	13·50	19·25	46·00	78·75
Intermission XI	5	286	291	289	11·50	14·25	12·75	38·50	60·50	3·25	14·75	78·50	7·50	21·50	50·00	79·00
Paroxysm XII	3	273	282	274	6·50	3·00	1·75	11·25	14·75	11·50	0·00	26·25	4·50	6·50	15·75	26·75
Post mortem										Removed from intestines						64·00

TABLE XXVIII.

Buffalo I.

Showing the Weight of Animal, Grass eaten, Water drunk and Dung passed during the massed periods.

Periods.	No. of days.	Weight of animal.			Grass eaten.				Water drunk.				Dung passed.			
		12 noon.	5 P.M.	8 A.M.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Observation	14	358	363	359	...	...	...	208·50	130·00	10·50	28·50	168·50	...	...	...	191·00
Latent Period	5	357	361	356	...	...	...	56·50	17·25	24·00	23·75	65·00	...	...	...	63·25
Paroxysms	39	327	329	331	106·25	113·75	96·50	346·00	294·25	122·00	137·00	553·25	173·25	210·00	256·75	703·00
Intermissions	81	328	331	330	246·00	264·25	243·75	754·00	760·25	220·25	333·25	1,313·75	368·75	456·00	593·50	1,418·25
Whole Period	139	342	346	334	...	...	...	1,365·00	1,201·75	376·75	522·00	2,100·50	...	...	...	*2,439·50
Percentage	...	...	...	...	...	...	...	...	57·21	13·17	24·85	...	...	...	...	...

* Added 64 lbs. dung found at *post mortem*.

TABLE XXIX.

BUFFALO I.

Showing the quantity of the constituents of the Urine during a preliminary period of observation, and the phases of Surra.

Periods.	Number of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Preliminary Observation .	14	41·75	753·81	82·102	19·478	58·792	3·826
Latent Period . . .	5	11·05	261·84	26·480	5·156	20·422	0·901
Paroxysm I . . .	3	9·20	163·81	17·602	4·292	12·777	0·532
Intermission I . . .	3	9·75	164·60	18·671	4·548	12·838	1·284
Paroxysm II . . .	6	18·19	242·86	30·841	8·486	18·941	3·412
Intermission II . .	5	11·09	192·40	21·097	5·173	15·010	0·914
Paroxysm III . . .	2	4·40	112·62	12·433	2·053	8·784	1·597
Intermission III . .	8	21·85	333·42	39·019	10·194	26·006	2·822
Paroxysm IV . . .	4	12·18	123·78	15·921	5·683	9·653	·584
Intermission IV . .	6	16·51	218·08	25·474	7·700	17·009	·763
Paroxysm V . . .	2	4·27	82·86	8·531	1·991	6·463	·076
Intermission V . .	5	8·92	185·22	21·880	4·161	14·447	2·274
Paroxysm VI . . .	3	8·64	145·55	17·106	4·031	11·352	1·724
Intermission VI . .	6	17·03	340·61	37·642	7·946	26·567	3·132
Paroxysm VII . .	2	5·43	90·56	11·074	2·533	7·063	1·478
Intermission VII . . .	14	40·84	749·50	88·033	19·048	58·454	10·522
Paroxysm VIII . .	4	10·14	208·55	23·739	4·730	16·265	2·743
Intermission VIII . .	8	23·41	425·23	58·589	10·918	32·765	15·002
Paroxysm IX . . .	2	5·37	102·78	14·694	2·504	8·016	4·173
Intermission IX . .	14	41·90	685·18	89·316	19·544	53·438	16·330
Paroxysm X . . .	3	11·00	124·13	16·675	5·131	9·681	1·862
Intermission X . .	7	23·09	281·13	37·352	10·771	21·924	4·654
Paroxysm XI . . .	5	37·08	150·52	33·308	17·298	11·738	4·268
Intermission XI . .	5	99·93	108·65	57·114	46·626	8·472	2·014
Paroxysm XII . .	3	100·56	57·64	53·045	42·254	4·495	6·295
Post Mortem . . .	...	6·45	...	3·203	3·009	...	0·194

TABLE XXX.

BUFFALO I.

Showing the quantity of the constituents of the Urine for the massed periods.

Periods.	Number of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Observation . . .	14	41·75	753·81	82·102	19·478	58·792	3·826
Latent Period . . .	5	11·05	261·84	26·480	5·156	20·422	0·901
Paroxysms . . .	39	226·46	1,605·66	254·969	100·986	125·228	28·744
Intermissions . . .	81	314·32	3,621·02	494·187	146·629	285·930	59·711
Whole Period . . .	139	593·58	6,242·33	857·738	272·249	490·372	93·182

TABLE XXXI.

Buffalo I.

Showing the mean daily quantity of the constituents of the Urine during a preliminary period of observation and the phases of Surra.

Periods.	Number of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes
Preliminary Observation .	14	2·98	53·84	5·864	1·391	4·199	0·273
Latent Period . . .	5	2·21	52·37	5·296	1·031	4·084	0·180
Paroxysm I . . .	3	3·07	54·60	5·867	1·430	4·259	0·177
Intermission I . . .	3	3·25	54·86	6·223	1·516	4·279	0·428
Paroxysm II . . .	6	3·03	40·47	5·140	1·414	3·157	0·569
Intermission II . .	5	2·22	38·48	4·219	1·034	3·002	0·183
Paroxysm III . . .	2	2·20	56·31	6·216	1·026	4·392	0·798
Intermission III . .	8	2·73	41·68	4·877	1·274	3·250	0·353
Paroxysm IV . . .	4	3·04	30·94	3·980	1·420	2·413	0·146
Intermission IV . .	6	2·75	36·35	4·245	1·283	2·835	0·127
Paroxysm V . . .	2	2·13	41·43	4·265	0·995	3·231	0·038
Intermission V . .	5	1·78	37·04	4·376	0·832	2·889	0·455
Paroxysm VI . . .	3	2·88	48·51	5·702	1·343	3·784	0·574
Intermission VI . .	6	2·84	56·77	6·273	1·324	4·428	0·522
Paroxysm VII . . .	2	2·71	45·28	5·537	1·266	3·551	0·739
Intermission VII . .	14	2·91	53·53	6·288	1·360	4·175	0·751
Paroxysm VIII . .	4	2·53	52·14	5·935	1·182	4·066	0·686
Intermission VIII . .	8	2·92	53·15	7·323	1·365	4·096	1·875
Paroxysm IX . . .	2	2·68	51·39	7·317	1·252	4·008	2·086
Intermission IX . .	14	2·99	48·94	6·379	1·396	3·817	1·166
Paroxysm X . . .	3	3·66	41·38	5·558	1·710	3·227	0·621
Intermission X . . .	7	3·29	40·16	5·336	1·539	3·132	0·665
Paroxysm XI . . .	5	7·41	30·10	6·661	3·459	2·347	0·853
Intermission XI . .	5	19·98	21·73	11·423	9·325	1·694	0·403
Paroxysm XII . .	3	33·52	19·21	17·681	14·084	1·498	2·098

TABLE XXXII.

Buffalo I.

Showing the mean daily quantity of the constituents of the Urine in the massed periods.

Periods.	Number of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in.		
					Urea.	Hippuric Acid.	NH_3.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Observation . . .	14	2·98	53·84	5·864	1·391	4·199	0·273
Latent Period . . .	5	2·21	52·37	5·296	1·031	4·084	0·180
Paroxysms . . .	39	5·74	2·64	6·657	2·548	3·326	0·782
Intermissions . . .	81	4·33	43·88	6·087	2·022	3·418	0·629
Whole Period . . .	139	4·87	44·90	6·320	2·210	3·431	0·670

TABLE XXXIII.

Buffalo I.

Showing the mean daily averages, with percentages and ratios in a preliminary period of observation and Surra, of the Urine and its constituents, together with the Water drunk and Dung passed.

Periods.		Preliminary Observation.	Latent Period.	Paroxysm I.	Intermission I.	Paroxysm II.	Intermission II.	Paroxysm III.	Intermission III.	Paroxysm IV.	Intermission IV.	Paroxysm V.	Intermission V.	Paroxysm VI.	Intermission VI.	Paroxysm VII.	Intermission VII.	Paroxysm VIII.	Intermission VIII.	Paroxysm IX.	Intermission IX.	Paroxysm X.	Intermission X.	Paroxysm XI.	Intermission XI.	Paroxysm XII.	*Post Mortem.*
Days		14	5	3	3	6	5	2	3	4	6	2	5	3	6	2	14	4	3	2	14	3	7	5	5	3	
	Quantity.																										
Urine	C.C.	1,250	987	1,533	1,083	864	494	770	800	460	686	615	673	1,166	1,155	1,000	1,320	1,075	1,242	1,335	1,067	785	689	946	874	1,245	1,040
Ratio	...	1	0·79	1·22	0·86	0·69	0·39	0·61	0·64	0·37	0·55	0·49	0·54	0·93	0·92	0·80	1·05	0·86	0·99	1·07	0·85	0·63	0·51	0·75	0·69	0·99	...
Urea	Grammes	2·982	2·210	3·066	3·250	3·031	2·218	2·200	2·731	3·045	2·751	2·135	1·784	2·830	2·833	2·715	2·917	2·537	2·926	2·685	2·993	3·666	3 299	7·416	19 986	33 520	6·450
Ratio	...	1	0·74	1·03	1·09	1·01	0·74	0·74	0·91	1·02	0·91	0·71	0·59	0·97	0·95	0·91	0·98	0·85	0 98	0 90	1·00	1·23	1·10	2·49	6·70	11·24	...
Hippuric Acid	Grammes	53·84	52·37	54·60	54·86	40·47	38·48	56·31	41·68	30·94	36·35	41·43	37·04	48·51	56·77	45·28	53·53	52·14	53·15	51·39	48·94	41·38	40·16	30 10	21·73	19·21	...
Ratio	...	1	0·97	1·01	1·02	0·75	0·71	1·04	0·77	0·57	0·67	0·77	0·68	0·90	1·05	0 84	0·99	0·96	0·98	0·95	0·90	0·76	0·74	0·56	0·40	0·35	...
Albumen	Grammes	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total Solids	Ditto	140·69	101·92	139·04	108·47	89·79	75·68	105·35	86·24	56·14	67·49	85·91	78·27	117·58	129·65	103·85	125·83	112·16	126·73	139·18	112·73	99·39	83·34	79·66	75·97	91·71	14·04
Ratio	...	1	0·72	0·99	0·77	0·63	0·53	0·75	0·61	0·39	0·48	0·61	0·55	0·83	0 92	0·73	0·89	0·79	0 90	0 99	0·80	0·70	0·59	0·56	0·54	0·65	...
Water drunk	Litres	5·47	5·90	6·06	5·98	5·32	5·36	6·81	9·54	7·16	6·59	7·95	5·40	6·51	6·85	6·47	8 42	7·92	7 89	7·72	7·39	5 83	6 85	6·81	7·13	3·97	...
Ratio	...	1	1·07	1·10	1·09	0·97	0·98	1·24	1·74	1·30	1·20	1·45	0·98	1·19	1·25	1·18	1·53	1·44	1·44	1·40	1·35	1·06	1·25	1·25	1·30	0·72	...
Ratio Urea : Urine	1 :	419	446	500	333	285	222	350	292	151	249	283	377	405	406	368	452	424	424	497	356	214	194	127	43 8	37·1	161
Ratio Urine : Water drunk	1 :	4·37	5·98	3 95	5·52	6·15	10·85	8·85	11·92	15·56	9·60	12·93	8·03	5 59	5·93	6·47	6 83	7·37	6 35	5·79	6·92	7·44	10·72	720	8·16	3 19	...
Ratio Water egested : ingested	1 :	1·15	1·28	0·77	0·87	0·71	0·87	1 07	1·30	1·00	0·96	1·44	1·01	0·80	0·98	0·93	1·01	0·98	1·28	1·13	1·18	1·17	1·13	1·07	1·12	0·92	...
Dung passed	Kilos	6·201	5·750	9·545	8·672	9·827	8·318	7·954	9·204	9·772	8·674	6·818	6·477	9 390	7·954	8·068	9·545	9·600	6·618	7·386	7·069	5·871	7·110	7·159	7·181	4·053	29·090
Ratio	...	1	0·92	1·54	1·39	1·58	1·34	1·29	1·48	1·57	1·40	1·09	1·04	1·51	1·28	1·30	1·54	1·54	1·06	1·19	1·14	0 94	1·14	1·15	1·15	0·65	...

TABLE XXXIV.

Buffalo I.

Showing the mean daily averages, with percentages and ratios in the massed periods, of the Urine and its constituents, together with the Water drunk and Dung passed.

Periods.		Preliminary Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Days.		14	5	39	81	139
	Quantity.					
Urine	C.C.	1250	987	982	912	1,004
Ratio	...	1	0·79	0·78	0·72	0·80
Urea	Grammes	2·982	2·210	5 741	4·336	4·87
Ratio	...	1	0·74	1·92	1·45	1·63
Hippuric Acid	Grammes	53·84	52 37	42 64	43·88	44·90
Ratio	...	1	0·97	0·79	0·81	0·83
Albumen	Grammes	...	...	...	...	...
Total Solids	„	140·69	101·92	101·64	97·31	101·87
Ratio	...	1	0 72	0·72	0·69	0 72
Water drunk	Litres	5·47	5·90	6 54	7·03	6·23
Ratio	...	1	1·07	1·19	1·28	1·13
Ratio { Urea / Urine	...	419	446	171	210	206
Ratio { Urine / Water drunk	...	4·87	5·98	6·66	7·70	6·20
Ratio { Water egested / „ ingested	...	1··5	1·28	1·00	1·06	1·12
Dung passed	Kilos	6·201	5·750	7 953	7·893	7·769
Ratio	...	1	0·92	1·28	1·27	1 25

TABLE XXXV.

Buffalo I

Showing the total amount of Nitrogen ingested and egested during a preliminary period of observation, and the phases of Surra.

Maximum weight=163·6 Kilos. Minimum weight=121·3 Kilos.

Periods.	Days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	14	394·25	82·102	169·29	251·392	142·858	...	163·6
Latent Period	5	106·83	26·480	56·06	82·540	24·290	...	162·7
Paroxysm I	3	55·78	17·602	55·84	73·442	...	17·662	161·8
Intermission I	3	54·83	18·671	50·74	69·411	...	14·581	161·8
Paroxysm II	6	104·94	30·841	115·00	145·841	...	40·901	160·0
Intermission II	5	88·40	21·097	81·10	102·197	...	13·797	158·4
Paroxysm III	2	32·62	12·433	31·02	43·453	...	10·833	157·2
Intermission III	8	173·02	39·019	143·13	182·149	...	9·129	160·9
Paroxysm IV	4	92·65	15·258	76 22	91·478	1·172	...	160·0
Intermission IV	6	123·85	25·474	101·49	126·964	...	3·114	155 9
Paroxysm V	2	31·20	8·531	26·59	35·121	...	3·921	162·2
Intermission V	5	84·62	21·880	63·15	85·030	...	·410	157·2
Paroxysm VI	3	46·32	17·106	54·95	72·056	...	25·736	154·1
Intermission VI	6	103·05	37·642	93·07	130·712	...	27·662	150·0
Paroxysm VII	2	31·20	11·074	31·46	42·534	...	11·334	150 9
Intermission VII	14	269·93	88·033	260·59	348·623	...	78·693	149·1
Paroxysm VIII	4	85 09	23·739	74·89	98·629	...	13·539	149·1
Intermission VIII	8	118·18	58·589	103·26	161·849	...	43·669	144·1
Paroxysm IX	2	29·78	14·694	28·80	43·494	...	13·714	145·0
Intermission IX	14	235·89	89·316	193·00	282·316	...	46·426	142·2
Paroxysm X	3	47·74	16·675	33·89	50·565	...	2·825	135·4
Intermission X	7	101·16	37·352	97·05	134·402	...	33·242	137·2
Paroxysm XI	5	75·64	33·308	69·80	102·108	...	26·468	133·9
Intermission XI	5	72·80	57·114	70·02	127·134	...	54·334	131 2
Paroxysm XII	3	21·27	56·248	23·71	79·958	...	58·688	125 6
Post Mortem	...	...	...	56·72	...	...	...	...

TABLE XXXVI.

Buffalo I.

Showing the Nitrogen ingested and egested in the massed periods.

Periods.	No. of Days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	14	394·25	82·102	169·29	251·392	142·858	...	163·6
Latent Period .	5	106·83	26·480	56·06	82·540	24·290	...	162·7
Paroxysms .	39	654·23	257·509	622·17	879·679	...	224·449	149·6
Intermissions .	81	1,425·73	494·187	1,256·60	1,750·247	...	325·057	149 8
Whole Period .	139	2,581·04	860·278	2,160·84	3,021·118	...	382·358	150·7

56·72 Grammes N in Dung added of *Post Mortem*.

TABLE XXXVII.

Buffalo I.

Showing the mean daily amount of Nitrogen ingested together with that egested by the Urine and in the Dung.

Periods.	Days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	14	28·16	5·864	12·09	17·954	10·206	...	163·6
Latent Period .	5	21·36	5·296	11·21	16·506	4·854	...	162·7
Paroxysm I .	3	18·59	6·537	18 61	25·147	...	6·557	161·8
Intermission I .	3	18·27	6·223	13·58	19·803	...	1·533	161·8
Paroxysm II .	6	17·49	5·140	19·17	24·310	...	6·820	160·0
Intermission II .	5	17·68	4·219	16·22	20·439	...	2·759	158·4
Paroxysm III .	2	16·31	6·216	15·51	21·726	...	5·416	157·2
Intermission III .	8	21·63	4·877	17·89	22·767	..	1·137	160·9
Paroxysm IV	4	23·16	3·814	19·05	22·864	0·296	...	160·0
Intermission IV .	6	20·16	4·246	16·91	21·156	...	0·516	155·9
Paroxysm V .	2	15·60	4·265	13·29	17·555	...	1 955	162 2
Intermission V .	5	16·92	4·376	12·63	17·006	...	0·086	157·2
Paroxysm VI .	3	15·44	5·702	18·32	24 022	...	8·582	154·1
Intermission VI .	6	17·17	6·273	15·51	21·783	...	4·613	150 0
Paroxysm VII .	2	15·60	5·537	15·73	21·267	...	5·667	150·9
Intermission VII .	14	19·28	6·288	18·61	24·898	...	5·618	149·1
Paroxysm VIII .	4	21·25	5·935	18·72	24·655	...	3·405	149·1
Intermission VIII	8	14·77	7·324	12·91	20·234	...	5·464	144·1
Paroxysm IX .	2	14·89	7·347	14·40	21·747	...	6·857	145·0
Intermission IX .	14	16 84	6·379	13·78	20·159	...	3·319	142·2
Paroxysm X .	3	15·91	5·558	11·29	16·848	...	0·938	135·4
Intermission X .	7	14·75	5·334	13·76	19·094	...	4·344	137·2
Paroxysm XI .	5	15·13	6·661	13·96	20·621	...	5·491	133·9
Intermission XI .	5	14·56	11·423	14·00	25·423	...	10·863	131·2
Paroxysm XII .	3	7·09	18·749	7·90	26·649	...	19·559	125·6

TABLE XXXVIII.

BUFFALO I.—*Showing the mean daily amount of Nitrogen ingested and egested in the massed periods.*

PERIODS.	No. of days.	INGESTED.	EGESTED			DIFFERENCE.		Mean body-weight.
		Total Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	14	28·16	5·864	12·09	17·954	10·206	...	163·6
Latent Period .	5	21·36	5 296	11·21	16·506	4·854	...	162·7
Paroxysms . .	39	16·37	6 788	15·49	22·278	0 296	6·478	149·6
Intermissions .	81	17·50	6·087	15·07	21·157	...	3·652	149·8
Whole Period .	139	20·85	6·008	13·46	19·468	5·118	5·065	150·7

2,581·04 grammes Nitrogen in Hay.
2,160·84 „ „ in Dung.

420·20 „ assimilated Nitrogen.

860·278 grammes Nitrogen in Urine.
420·200 „ „ assimilated.

440·078 „ Nitrogen actually lost as flesh.
42·4 ratio of Nitrogen per cent in flesh examined.

18,659·3 Kilos.
·0022

41·05046 lbs. flesh lost by Nitrogen.

Total loss in body weight { lbs 359 at commencement. 267 at death. 92 = 41·81 Kilos.

Loss by Nitrogen . . 44·62 per cent.
„ „ Co_2, moisture, etc., 55·38 „

On reference to the Table we find that during the period of preliminary observation, the assimilated Nitrogen was practically 57·06 per cent. of the total amount ingested; in the latent period this decreased to 47·52 per cent. but in the paroxysmal periods only 4·90 per cent. was utilized at all. In the intermissions, however, about 11·83 per cent. passed into the system. This non-assimilation during the paroxysms can be readily understood when we consider the fever accompanying the presence of vast numbers of the hæmatozoa in the circulation. During the whole period of 138 days the percentage of Nitrogen assimilated was 18·47·

TABLE XXXIX.

BUFFALO I.

Showing the amount of Water ingested and egested and percentage excreted in Urine and Dung.

PERIODS.	No. of days.	Water in grass.	Water drunk.	Total ingested.	Water in Urine.	Water in Dung.	Total egested	Difference between Ingested and Egested.	%Ingested water excreted as Urine.	%Excreted in Dung.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.		
Preliminary Observation.	14	23,276	76,590	99,866	15,536	71,118	86,654	+13,212	...	...
Mean daily . .	...	1,662	5,470	7,131	1,109	5,079	6,189	+943	15·55	71·11
Latent Period .	5	6,307	29,545	35,852	4,425	23,550	27,975	+7,877	...	...
Mean daily . .	...	1,261	5,909	7,170	885	4,710	5,595	+1,575	12·34	65·69
Paroxysm I . .	3	3,298	18,182	21,475	4,182	23,459	27,641	−6,166	...	...

Showing the amount of Water ingested and egested and percentage excreted in Urine and Dung—concld.

Periods.	No. of days.	Water in grass.	Water drunk.	Total ingested.	Water in Urine.	Water in dung.	Total egested.	Difference between Ingested and egested.	%Ingested water excreted as Urine.	%Excreted in dung.
Mean daily . .	...	1,097	6,060	7,158	1,394	7,819	9,213	—2,055	19·47	109·23
Intermission I .	3	3,237	17,955	21,192	2,925	21,318	24,243	—3,051	...	...
Mean daily . .	...	1,079	5,985	7,064	975	7,106	8,081	—1,017	13·81	100·59
Paroxysm II . .	6	6,195	31,932	38,127	4,655	48,314	52,969	—14,842	...	...
Mean daily . .	...	1,032	5,322	6,354	775	8,052	8,828	—2,474	12·19	126·72
Intermission II .	5	5,219	26,818	32,037	2,092	34,355	36,447	—4,410	...	...
Mean daily . .	...	1,043	5,363	6,407	418	6,871	7,289	—882	6·52	107·24
Paroxysm III .	2	1,925	13,636	15,561	1,329	13,141	14,470	+1,091	...	...
Mean daily . .	...	962	6,818	7,780	664	6,570	7,235	+545	8·53	84·44
Intermission III .	8	10,214	76,363	86,577	5,710	60,824	66,534	+20,043	...	...
Mean daily . .	...	1,277	9,543	10,822	713	7,603	8,316	+2,505	6·58	70·25
Paroxysm IV . .	4	5,470	28,636	34,106	1,615	32,289	33,904	+202	...	...
Mean daily . .	...	1,367	7,159	8,526	403	8,072	8,476	+50	4·72	94·67
Intermission IV .	6	7,314	39,545	46,859	3,715	45,071	48,786	—1,927	...	...
Mean daily . .	...	1,219	6,590	7,809	619	7,512	8,132	—321	7·78	96·19
Paroxysm V . .	2	1,842	15,909	17,751	1,058	11,264	12,322	+5,429	...	...
Mean daily . .	...	921	7,954	8,875	529	5,632	6,161	+2,714	5·96	63·45
Intermission V .	5	3,458	27,045	30,503	2,974	27,045	3,019	+484	...	...
Mean daily . .	...	691	5,409	6,100	594	5,409	6,003	+97	9·74	88·67
Paroxysm VI . .	3	1,893	19,545	21,438	3,147	23,536	26,683	—5,245	...	...
Mean daily . .	...	631	6,515	7,146	1,049	7,845	8,894	—1,748	14·67	109·78
Intermission VI .	6	4,211	41,136	45,347	6,152	39,855	46,007	—660	...	...
Mean daily . .	...	701	6,856	7,557	1,025	6,642	7,664	—110	13·55	87·89
Paroxysm VII .	2	1,275	12,955	14,230	1,792	13,477	15,269	—1,039	...	...
Mean daily . .	...	637	6,477	7,115	896	6,738	7,634	—519	12·53	94·70
Intermission VII .	14	10,688	117,954	128,642	16,723	110,597	127,320	+1,322	...	...
Mean daily . .	...	763	8,425	9,188	1,194	7,899	9,094	+94	12·99	85·97
Paroxysm VIII .	4	3,368	31,704	35,072	3,851	31,787	35,638	—566	...	...
Mean daily . .	...	842	7,926	8,768	962	7,946	8,909	—141	10·97	90·62
Intermission VIII .	8	4,679	63,181	67,860	8,926	43,825	52,751	+15,109	...	...
Mean daily . .	...	584	7,897	8,482	1,115	5,478	6,593	+1,888	13·14	64·58
Paroxysm IX . .	2	1,179	15,454	16,633	2,392	12,226	14,618	+2,015	...	...
Mean daily . .	...	589	7,727	8,316	1,196	6,113	7,309	+1,007	14·38	73·51
Intermission IX .	14	9,639	103,409	113,048	13,367	81,854	95,221	+17,827	...	...
Mean daily . .	...	688	7,386	8,074	955	5,845	6,801	+1,273	11·82	72 39
Paroxysm X . .	3	1,951	17,522	19,473	2,057	14,566	16,623	+2,850	...	...
Mean daily . .	...	650	5,841	6,491	686	4,855	5,541	+950	10·57	74·79
Intermission X .	7	2,405	47,954	50,359	3,891	40,664	44,555	+5,804	...	...
Mean daily . .	...	343	6,850	7,194	556	5,809	6,365	+829	7·73	80·75
Paroxysm XI .	5	1,798	34,091	35,889	4,331	29,244	33,575	+2,314	...	...
Mean daily . .	...	359	6,818	7,177	866	5,848	6,715	+463	12·06	81·48
Intermission XI .	5	1,731	35,682	37,413	3,990	29,338	33,328	+4,085	...	...
Mean daily . .	...	346	7,136	7,482	798	5,867	6,665	+817	10 66	78·41
Paroxysm XII .	3	505	11,932	12,437	3,460	9,934	13,394	—957	...	...
Mean daily . .	...	168	3,977	4,145	1,153	3,311	4,464	—319	27·81	79·37

TABLE XL.

Buffalo I.

Showing the percentages of ingested water excreted as Urine, in the Dung and by the Lungs and Skin.

Periods.	Length in days.	Urine, per cent.	In dung, per cent.	Lungs, sweat, etc.	Total.
Observation	14	15·55	71·11	13·34	100
Latent Period	5	12·34	65·69	21·97	100
Paroxysm I	3	19·47	109·23	*	...
Intermission I	8	13·81	100·59	*	...
Paroxysm II	6	12·19	126·72	*	...
Intermission II	5	6·52	107·24	*	...
Paroxysm III	2	8·53	84·44	7·03	100
Intermission III	8	6·58	70·25	23·17	100
Paroxysm IV	4	4·72	94 67	0·61	100
Intermission IV	6	7·78	96·19	*	...
Paroxysm V	2	5·96	63·45	30·59	100
Intermission V	5	9·74	88·67	1·59	100
Paroxysm VI	3	14·67	109·78	*	...
Intermission VI	6	13·55	87·89	*	...
Paroxysm VII	2	12·53	94·70	*	...
Intermission VII	14	12·99	85·97	1·04	100
Paroxysm VIII	4	10·97	90·62	*	...
Intermission VIII	8	13·14	64 58	22·28	100
Paroxysm IX	2	14·38	73·51	12·11	100
Intermission IX	14	11·82	72·39	15·79	100
Paroxysm X	3	10·57	74·79	14·64	100
Intermission X	7	7·73	80·75	11·52	100
Paroxysm XI	5	12·06	81·48	6·46	100
Intermission XI	5	10·66	78·41	10·93	100
Paroxysm XII	3	27·81	79·87	*	...

* Egested water exceeded Ingested.

TABLE XLI.

Buffalo I.

Percentage of dry matter digested during a preliminary period of observation, and the phases of Surra.

Periods.		Total dry matter ingested.	:	100	: :	Total dry matter digested.	:	Per cent. of dry matter digested in different periods.
		Kilos.				Kilos.		
Observation	As	71·500	:	100	: :	55·800	:	78·04
Latent Period	,,	19·377	:	100	: :	14·177	:	73·16
Paroxysm I	,,	10·118	:	100	: :	4·941	:	48·83
Intermission I	,,	9·945	:	100	: :	5·240	:	52·69
Paroxysm II	,,	19·032	:	100	: :	8·368	:	43·96
Intermission II	,,	16·032	:	100	: :	8·796	:	54·86
Paroxysm III	,,	5·918	:	100	: :	3·149	:	53·21
Intermission III	,,	31·364	:	100	: :	18·546	:	59·13
Paroxysm IV	,,	16·845	:	100	: :	10·027	:	59·52
Intermission IV	,,	22·464	:	100	: :	15·491	:	68·95
Paroxysm V	,,	5·659	:	100	: :	3·286	:	58·06
Intermission V	,,	16·886	:	100	: :	11·545	:	68·37
Paroxysm VI	,,	9·245	:	100	: :	4·600	:	43·26
Intermission VI	,,	20·563	:	100	: :	12·690	:	61·71
Paroxysm VII	,,	6·227	:	100	: :	3·568	:	57·29
Intermission VII	,,	53·859	:	100	: :	31·823	:	59·08
Paroxysm VIII	,,	17·00	:	100	:	10·364	:	60·96
Intermission VIII	,,	23·591	:	100	: :	14·410	:	61·08
Paroxysm IX	,,	5·941	:	100	: :	3·396	:	57·16
Intermission IX	,,	47·064	:	100	: :	29 941	:	63·61
Paroxysm X	,,	9·527	:	100	: :	6·482	:	68·03
Intermission X	,,	21·909	:	100	: :	12·818	:	58·50
Paroxysm XI	,,	16·381	:	100	: :	9·827	:	59 99
Intermission XI	,,	15·773	:	100	: :	9·182	:	58·21
Paroxysm XII	,,	4·609	:	100	: :	2·382	:	51·68

TABLE XLII.

Buffalo I.

Percentages during massed periods.

Periods.		Total dry matter, ingested.	:	100	::	Total dry matter digested.	:	Per cent. of dry matter digested in different periods.
		Kilos.				Kilos.		
Observation	As	71·500	:	100	: :	55·800	:	78·04
Latent Period	„	19·377	:	100	: :	14·177	:	73·16
Paroxysms	„	126·502	:	100	: :	70·390	:	55·64
Intermissions	„	279·450	:	100	: :	170·482	:	61·00
Whole Period	„	496·829	:	100	: :	316·167	:	63·63

	Kilos.	
Total Hay eaten	620·521	
Less H_2O	123·692	
	496·829	Total dry matter ingested.
Total Dung	1,098·019	
Less H_2O	917·357	
	180·662	Dry dung.

	Kilos.
Total dry matter ingested	496·829
„ „ „ egested	180·662
Dry matter digested	316·167

As 496·829 : 100 : : 316·167 : 63·63 per cent. dry matter digested for whole period.

TABLE XLIII.

Buffalo I.

Showing the mean daily number of the different blood corpuscles in 1 C. mm. with the ratios to one another, together with the percentage of Hæmoglobin during a period of observation and disease (Surra).

Periods.	Hæmatozoa		Hæmoglobin.	Red Corpuscles.	White Corpuscles.	Coarsely Granular Corpuscles.	Hæmatozoa.	Ratio White to Red Corpuscles.	Ratio Coarsely Granular Corpuscles to White Corpuscles.	Ratio Coarsely Granular Corpuscles to Red Corpuscles.	No. of days.
	Maximum.	Minimum.		in 1 c. mm.							
Observation	...	...	100	9,250,714	19,964	2 035	...	1 : 463	1 : 9·8	1 : 4,545	14
Latent Period	...	...	102	9,628,600	18,800	2,200	...	1 : 512	1 : 8·5	1 : 4,376	5
Paroxysm I	N.	F.	104	9,920,000	19,666	1,333	9,000	1 : 504	1 : 14·7	1 : 7,442	3
Intermission I	...	...	100	9,353,333	21,000	2,166	...	1 : 446	1 : 9·7	1 : 4,318	3
Paroxysm II	N.	F.	100	8,800,000	14,833	1,000*	11,500	1 : 593	1 : 14·8	1 : 8,800	6
Intermission II	...	...	96	8,310,000	16,700	3,900	...	1 : 497	1 : 4·3	1 : 2,131	5
Paroxysm III	N.	F.	100	8,600,000	17,500	1,750	6,000	1 : 491	1 : 10·0	1 : 4,914	2
Intermission III	...	...	95	8,300,000	14,250	1,917	...	1 : 582	1 : 7·0	1 : 4,329	3
Paroxysm IV	F.	F.	100	8,410,000	16,730	1,361	8,500	1 : 502	1 : 12·3	1 : 6,179	4
Intermission IV	...	...	94	8,290,000	17,300	2,600	...	1 : 479	1 : 6·6	1 : 3,188	6
Paroxysm V	F.	F.	93	8,245,000	26,250	2,250	51	1 : 314	1 : 11·6	1 : 3,664	2
Intermission V	...	...	93	8,288,000	28,600	4,500	....	1 : 289	1 : 6·3	1 : 1,842	5
Paroxysm VI	F.	F.	93	8,206,666	20,833	2,833	34	1 : 393	1 : 7·3	1 : 2,897	3
Intermission VI	...	...	92	8,276,666	22,083	2,917	...	1 : 374	1 : 7·5	1 : 2,837	6
Paroxysm VII	F.	F.	90	8,290,000	29,000	2,000	400	1 : 286	1 : 14·5	1 : 4,145	2
Intermission VII	...	...	86	7,957,936	26,444	3,464	...	1 : 300	1 : 7·6	1 : 2,297	14
Paroxysm VIII	N.	F.	85	7,965,000	18,875	2,666	3,000	1 : 422	1 : 7·0	1 : 2,989	4
Intermission VIII	...	...	83	7,847,500	20,750	2,500	...	1 : 378	1 : 8·3	1 : 3,139	8
Paroxysm IX	F.	F.	83	7,915,000	16,250	1,750	1	1 : 487	1 : 9·2	1 : 4,523	2
Intermission IX	...	...	78	7,489,286	22,607	4,352	...	1 : 331	1 : 5·2	1 : 1,719	14
Paroxysm X	V.N.	F.	74	7,193,333	23,833	6,167	38,000	1 : 302	1 : 3·8	1 : 1,166	3
Intermission X	...	...	71	6,620,000	36,143	9,214	...	1 : 183	1 : 3·9	1 : 718	7
Paroxysm XI	N.	F.	72	6,470,000	25,100	3,300	22,000	1 : 258	1 : 7·6	1 : 1,960	5
Intermission XI	...	...	71	6,158,000	23,400	7,300	...	1 : 263	1 : 3·2	1 : 843	5
Paroxysm XII	S.	F.	68	5,996,666	18,333	3,167	90,000	1 : 327	1 : 5·8	1 : 1,893	3

* On the fourth day of Paroxysm II the Coarsely Granular or Eosineophile Corpuscles were absent from the blood.

TABLE XLIV.

Buffalo I.

Showing the mean for Observation, Latent Period, Paroxysms, Intermissions and for the whole Period.

Periods.	Hæmoglobin.	Red Corpuscles.	White Corpuscles.	Coarsely Granular Corpuscles.	Hæmatozoa.	Ratio White to Red Corpuscles	Ratio Coarsely Granular Corpuscles to White Corpuscles	Ratio Coarsely Granular Corpuscles to Red Corpuscles	No. of days.
		in 1 c. mm.							
Observation . . .	100	9,250,714	19,964	2,035	...	1 : 463	1 : 9·8	1 : 4,545	14
Latent Period . . .	102	9,628,000	18,800	2,200	...	1 : 512	1 : 8·5	1 : 4,376	5
Paroxysms . . .	88	8,000,972	20,600	2,465	4,833	1 : 388	1 : 8·3	1 : 3,245	39
Intermissions . . .	87	7,899,157	22,661	4,076	...	1 : 348	1 : 5·5	1 : 1,938	81
Whole Period . . .	94	8,694,711	20,506	2,694	...	1 : 424	1 : 7·6	1 : 3,227	139

TABLE XLV.

Buffalo I.

Showing the percentage of Corpuscles in the massed periods, taking the number in the Observation as 100.

Periods.	Hæmoglobin.	Red Corpuscles.	White Corpuscles.	Coarsely Granular Corpuscles.
		in 1 c. mm.		
Observation . . .	100	100	100	100
Latent Period . . .	102	104	94·1	108·1
Paroxysms . . .	88	86·4	103·2	121·1
Intermissions . . .	87	85·4	113·5	200·3
Whole period . . .	94	93·9	102·7	132·3

Buffalo No. I.

Corpuscular changes in the blood.

Red corpuscles.—Taking 100 as the mean daily number during the period of observation, there was 4 per cent. increase in the latent period, which decreased 13·6 per cent. and 14·6 per cent. in the paroxysms and intermissions respectively. For the whole case the loss was 6·1 per cent.

White corpuscles.—There was a decrease of 5·9 per cent. in their number during the latent period, which rapidly increased to 3·2 per cent. until a maximum of 13·5 per cent was attained in the intermissions.

Coarsely granular oxyphile cells.—An increase of 8·1 per cent. occurred during the latent period, which was further added to 21·1 per cent. in the paroxysms until a maximum of 100·3 per cent. was reached in the intermissions. In the whole period of 139 days, the total rise in their numbers was 32·3 per cent.

Hæmoglobin.—Consistent with the increase of red corpuscles the Hæmoglobin was 2 per cent. higher in the latent period than that of the observation but during the paroxysms and intermissions there was a fall of 12 per cent. and 13 per cent. respectively.

BUFFALO No. II.

The following are the condensed results obtained from the investigation into the ingesta and egesta of a buffalo, aged 2½ years, with a view to ascertain the changes which occurred during a period of observation and later after contracting Surra.

After a period of observation lasting 31 days, this animal was inoculated on the ear with a drop of blood containing a few hæmatozoa taken from Buffalo No. I.

Body-weight.—From the commencement of this investigation, the animal was weighed three times daily until death, *viz.*, at 8 A.M., noon, and 5 P.M. There were exceedingly marked differences in the daily weights taken at these times, as much as 18 lbs. being lost or gained in the intervals between the weighings. It will be noticed that during the first 31 days of observation, which immediately preceded inoculation, the animal lost considerably in weight, although the appetite was normal, and the animal appeared in good health. This change in weight, we find, was due partly to loss of flesh and partly to water, CO_2, etc., and was probably owing to the changed circumstances under which the animal existed, it having been closely confined in a building without access to deep water, in which, when free, buffaloes usually lie nearly submerged for some hours daily.

On first weighing the animal registered 374 lbs., and 31 days later 347, although it was supplied with hay *ad libitum* and as much water as it would drink. The mean weight for this period was 362 lbs. After inoculation, and during the different stages of paroxysms and intermissions, there was a continuous loss, until at death the body weighed 297 lbs., a total loss of 77 lbs.

At the *post mortem* the intestines were found to contain 63·25 lbs. of dung, which represented in health 18·02 per cent. and at death 22·98 per cent. of the body-weight. The body showed a total absence of any visible adipose tissue.

Water drunk.—The average daily quantity of water drunk during the period of observation was 9·26 litres; it increased nearly two litres in the latent period (11 09), and reached a maximum of 16·82 litres during Intermission III. After this as the disease progressed the average quantity taken was reduced, until in Intermission VII it was only 1·02. The mean for the paroxysms and intermissions was practically identical, *viz.*, 10·90 and 10·24 litres, respectively. For the whole case the average daily quantity was 10·04 litres.

Water in food.—In addition to the above ·845 kilos (1·86lbs.) were taken in daily as moisture in the fodder, equal to a total of 10·89 kilos (23·96 lbs.) ingested. The ratio of water egested to ingested was in the observation period 1 : 1·16; it increased in the latent period to 1 : 1·41, whilst during the paroxysms it was practically the same as in the observation, slightly increasing in the intermissions. For the whole period of 82 days it was the same as in the observation.

Food.—This consisted of hay only. The ration contained a daily average of 0·416 per cent. of Nitrogen. During the whole case the animal ingested 1,581·532 grammes of Nitrogen and egested in the Dung 1,488·680 grammes, giving 92·852 grammes as assimilated Nitrogen. The total Nitrogen excreted in the Urine during the same period was 698·957 grammes. Deducting the amount of assimilated Nitrogen from this, 606·105 grammes are left, which represent the actual Nitrogen lost. Converting the Nitrogen eliminated to its equivalent as flesh, we obtain a loss of 25·698 kilos (56·537lbs). The total decrease in body-weight during the whole period was 35 kilos (77 lbs.) so that the loss by Nitrogen was equal to 73·42 per cent. the remaining 26·58 per cent. being due to Carbonic Acid, moisture, etc. No trace of adipose tissue was to be observed at the *post mortem*.

Urine.—The average quantity passed daily in the observation period was 1040 c.c, which was increased after inoculation to 1,594 c.c., and in the paroxysms it averaged 1453 c.c., increasing in the intermissions to 1,598 c.c. The average quantity passed daily throughout the whole case was 1499 c.c.

The maximum quantity, 2,020 c.c., was passed during Intermission II, and throughout the case it varied from that amount to as little as 610 c.c., in the period of preliminary observation. The specific gravity varied from 1,058 to 1,030, while the Urine taken from the bladder at *post mortem* was only 850 c.c., containing no Hippuric Acid and only 2·2 per cent. of total solids including 0·71 per cent. of Urea.

Urea.—The quantity of Urea excreted by this animal was exceedingly small, the average daily output in the observation period being only 3·211 grammes, and in the latent period 3·190 grammes. In the paroxysms this amount was quadrupled, 12·50 grammes being passed daily, but it fell again in the intermissions to 8·57 grammes daily, and for the whole period was 7·01 grammes. It will be noticed that when the Urea in the paroxysms increased the Hippuric Acid slightly decreased, and *vice versâ* in the intermissions.

Ratio of Urea to Urine.—During the period of observation at rest the average ratio was 1 : 323·9, in latent period 1 : 499·6, in the paroxysms 1:116·2, and in the intermissions 1:186·3, while for the whole period it was 1 : 213. This ratio shows a very marked difference to the results of our investigations with equines, but there is a corresponding rise during the disease in both instances.

Hippuric Acid.—In the period of observation this animal passed 49·32 grammes, which increased in the latent period to 61·89 grammes. In the paroxysms and intermissions the amounts were 55·70 and 55·69 grammes, the respective periods lasting 15 and 31 days. The mean for the whole period 82 days was 53·66 grammes. The maximum daily quantity, 90·72 grammes, was passed in Intermission III, and for the last 21 days of the case the amount excreted gradually decreased to 20·00 grammes, while the Urine passed during the 12 hours preceding death and that removed from the bladder (*post mortem*) contained no Hippuric Acid at all.

Of the total Nitrogen in the Urine during the different periods, the following table shows the percentage excreted:—

TABLE XLVI.

BUFFALO II.

PERIODS.	As Urea.	Hippuric Acid.	NH_3 and Kreatmin, etc.	TOTAL.
	%	%	%	%
Observation . .	25 81	66·28	7·36	100
Latent Period . .	20·03	64·96	15·01	100
Paroxysms . .	51·48	38 35	10·17	100
Intermissions . .	40·18	43·62	16·20	100
Whole Period . .	37·98	49·10	12·32	100

Albumen.—During the whole case no Albumen was present in the Urine until the day previous to death, when a trace was observed. There was also a trace in the Urine removed from the bladder (*post mortem*).

Total Solids in Urine.—The mean daily out-put during 82 days was 138·69 grammes. In the period of observation it was only 109·35; in the latent period 147·84. As in the case of Hippuric Acid the amounts during the paroxysms and intermissions were nearly identical, being 140·65 and 141·61 grammes respectively. The largest quantity, 224·47 grammes, was passed during Paroxysm VI, whilst the smallest quantity, *viz.*, 30·38 grammes, was passed during Intermission VII, the day of death. The percentage on the later day was the minimum recorded during the case, *viz.*, 4·9, the maximum percentage, 14·15, being in the observation period. Besides the Urea and Hippuric Acid there was a variable amount of Kreatmin and Ammonium Carbonate, and a large proportion of Potassium Carbonate and Lime. The ratio of the total solids in the different periods was:—

Observation	1·00
Latent Period	1·35
Paroxysms	1·28
Intermissions	1·29
Whole Period	1·26

Dung.—The average quantity passed daily throughout the whole case was 9·940 kilos (21·86 lbs.), containing on the average 81·58 per cent. of water and 0·250 per cent. of Nitrogen. In the observation period the amount was 9·72 kilos (21·40 lbs.), it decreased in the latent period to 8 59 kilos (18·90 lbs.), but rose again in the paroxysms and intermissions to 10·40 kilos (22·88 lbs.) and 10·16 kilos (22·37 lbs.) respectively. At the autopsy the total amount of dung contained in the intestines was 68·25 lbs. (31·02 kilos).

The ratio of the dung in the different periods was:—

Observation	1·00
Latent Period	0·88
Paroxysms	1·06
Intermissions	1·04
Whole Period	1·02

TABLE XLVII.

Buffalo II.

Showing the Weight of Animal, Grass eaten, Water drunk and Dung passed during a preliminary period of observation, and the phases of Sura.

Periods.	Number of days.	Weight of Animal.			Grass Eaten.				Water Drunk.				Dung Passed.			
		12 noon.	5 P.M.	8 A.M.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Observation	14	370	377	372	57·50	54·00	64·00	175·50	137·50	69·75	80·75	288·00	146·50	76·75	78·50	301·75
,,	17	350	351	354	54·75	61·50	59·75	176·00	136·00	100·50	107·00	343·50	122·75	125·00	114·00	361·75
Full Observation	31	360	364	363	112·25	115·50	123·75	351·50	273·50	170·25	187·75	631·50	269·25	201·75	192·50	663·50
Latent Period	5	336	339	341	19·75	17·00	19·75	56·50	59·50	28·00	34·50	122·00	56·00	20·50	18·00	94·50
Paroxysm I	1	345	346	344	2·50	4·50	4·50	11·50	15·00	0·00	5·00	20·00	8·50	11·50	5·00	25·00
Intermission I	2	338	339	340	4·75	8·00	8·00	20·75	28·00	9·00	22·00	59·00	12·00	25·50	4·00	41·50
Paroxysm II	2	348	348	338	5·00	9·00	6·00	20·00	17·00	2·50	30·00	49·50	14·50	9·50	8·00	32·00
Intermission II	4	343	334	331	17·50	12·00	15·00	44·50	57·00	8·00	32·00	97·00	28·50	50·00	63·50	142·00
Paroxysm III	4	350	343	344	14·75	16·50	9·50	40·75	45·50	22·00	45·50	113·00	33·00	35·50	58·00	126·50
Intermission III	1	350	332	348	5·25	3·50	3·00	11·75	21·00	0·00	16·00	37·00	4·50	4·00	12·00	20·50
Paroxysm IV	1	336	330	339	2·50	3·00	3·00	8·50	0·00	18·00	0·00	18·00	0·00	4·50	20·00	24·50
Intermission IV	9	334	333	328	29·50	28·50	25·75	83·75	134·50	53·50	27·50	215·50	45·50	39·50	100·00	185·00
Paroxysm V	1	338	331	338	3·50	3·00	3·00	9·50	8·00	6·00	4·00	18·00	7·00	7·50	6·00	20·50
Intermission V	8	334	337	335	31·50	29·00	23·25	83·75	163·75	18·50	23·00	205·25	38·00	60·75	103·25	202·00
Paroxysm VI	2	332	332	332	7·00	5·75	7·25	20·00	49·75	4·00	4·00	57·75	6·00	5·00	32·75	43·75
Intermission VI	4	317	332	320	12·50	12·00	12·50	37·00	76·50	0·00	4·00	80·50	18·75	24·75	46·25	89·75
Paroxysm VII	4	313	313	312	13·75	8·75	8·25	30·75	40·50	17·50	25·00	83·00	10·25	16·00	44·75	71·00
Intermission VII	3	302	301	304	0·75	1·75	1·00	3·50	0·00	4·50	0·00	4·50	0·00	5·75	7·00	12·75
Post mortem	...	...	...	...	...	...	...	...	...	...	Removed from intestines					68·25

TABLE XLVIII.

Buffalo II.

Showing the Weight of Animal Grass eaten, Water drunk and Dung passed for massed periods.

Periods.	Number of days.	Weight of Animal.			Grass eaten.				Water drunk.				Dung passed.			
		12 noon.	5 P.M.	8 A.M.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.	12 noon.	5 P.M.	8 A.M.	Total.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Observation	31	360	364	363	112·25	115·50	123·75	351·50	273·50	170·25	187·75	621·50	269·25	201·75	192·50	663·50
Latent Period	5	336	339	341	19·75	17·00	19·75	56·60	59·50	28·00	34·50	122·00	56·00	20·50	18·00	94·50
Paroxysms	15	337	335	335	49·00	50·50	41·50	141·00	175·75	70·00	113·50	359·25	79·25	89·50	174·50	343·25
Intermissions	31	331	328	329	101·75	94·75	88·50	285·00	490·75	93·50	124·50	698·75	147·25	210·25	336·00	693·50
Whole Period	82	341	341	342	282·75	277·75	273·50	834·00	969·50	361·75	460·25	1,811·50	551·75	522·00	721·00	1,863·00*
Percentage	...	...	...	...	33·90	33·30	32·79	...	54·62	19·96	25·40	...	29·61	28·02	38·70	...

* Added 68·25 lbs. found at *post mortem*.

TABLE XLIX.

Buffalo II.

Showing the quantity of the constituents of the Urine during a preliminary period of observation and the phases of Surra.

Periods.	No. of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes
Observation	14	50·27	637·31	80·342	23·452	49 705	6·182
,,	17	49·29	891·82	99·608	22·991	69·555	7·057
Latent Period	5	15·95	309·47	37·157	7·441	24·138	5·578
Paroxysm I	1	3·56	74·64	8·316	1·661	5·822	0·833
Intermission I	2	6·67	123·35	14·364	3·112	9·622	1·631
Paroxysm II	2	8·48	138·44	15·438	3·957	10 799	0·684
Intermission II	4	21·99	270·66	36·911	10·259	21·112	5·541
Paroxysm III	4	14·54	262·85	32·649	6·783	20·502	5·364
Intermission III	1	4·72	90·72	9·639	2·202	7·076	0·361
Paroxysm IV	1	2·72	54·27	6·470	1·269	4·233	0·968
Intermission IV	9	34·73	529·07	74·916	16·201	41·268	17·447
Paroxysm V	1	4·45	48·54	7·776	2·076	3·786	1·914
Intermission V	8	53·60	465·27	80·667	25·005	36·286	19·371
Paroxysm VI	2	30 34	112·57	29·089	14·156	8·780	6·153
Intermission VI	4	66·51	195·95	50·707	31·031	15·282	4·392
Paroxysm VII	4	123·48	144·27	70·229	57·614	11·252	1·362
Intermission VII	3	77·66	51·28	41·515	36·235	3·999	1·281
Post Mortem		6·03	0·00	3·162	...	...	...

TABLE L.

Buffalo II.

Showing the quantity of the constituents of the Urine in the massed periods.

Periods.	No. of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.
Observation	31	99·56	1,529·13	179·950	46·443	119·260	13·239
Latent Period	5	15·95	309·47	37·157	7·441	24·138	5·578
Paroxysms	15	187·57	835·58	169·967	87·516	65·174	17·278
Intermissions	31	265·88	1,726·30	308·719	124·045	134·645	50 024
Whole Period	82	574·99	4,400·48	698·955	265·445	343·217	68·119

TABLE LI.

Buffalo II.

Showing the mean daily quantity of the constituents of the Urine during a preliminary period of observation, and the phases of Surra.

Periods.	No. of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3
Observation	14	3·59	45·52	5·739	1·675	3·550	0·441
,, ...	17	2·89	52·46	5·859	1·352	4·091	0·415
Latent Period	5	3·19	61·89	7·431	1·488	4·827	1·115
Paroxysm I	1	3·56	74·64	8·316	1·661	5·822	0·833
Intermission I	2	3·33	61·67	7·182	1·556	4·811	0·815
Paroxysm II	2	4·24	69·22	7·719	1·978	5·399	0·342
Intermission II	4	5·49	67·66	9·227	2·565	5·278	1·385
Paroxysm III	4	3·63	65·71	8·162	1·696	5·125	1·341
Intermission III	1	4·72	90·72	9·639	2·202	7·076	0·361
Paroxysm IV	1	2·72	54·27	6·470	1·269	4·233	0·968
Intermission IV	9	3·86	58·78	8·324	1·800	4·585	1·938
Paroxysm V	1	4·45	48·54	7·776	2·076	3·786	1·914
Intermission V	8	6·70	58·16	10·083	3·125	4·536	2·421
Paroxysm VI	2	15·17	56·28	14·544	7·078	4·390	3·076
Intermission VI	4	16·63	48·99	12·677	7·758	3·820	1·098
Paroxysm VII	4	30·87	36·07	17·557	14·403	2·813	0·340
Intermission VII	3	25·88	17·09	13·838	12·078	1·333	0·427
Post Mortem	...	6·03	0·00	3·162	...	...	...

TABLE LII.

Buffalo II.

Showing the mean daily quantity of the constituents of the Urine in the massed periods.

Periods.	No. of days.	Urea.	Hippuric Acid.	Total Nitrogen.	Nitrogen in		
					Urea.	Hippuric Acid.	NH_3
Observation	31	3·21	49·327	5·805	1·498	3·847	0·427
Latent Period	5	3·19	61·894	7·431	1·488	4·827	1·115
Paroxysms	15	12·50	55·700	11·331	5·834	4·345	1·152
Intermissions	31	8·58	55·687	9·958	4·001	4·343	1·614
Whole Period	82	7·01	53·664	8·523	3·237	4·185	1·050

TABLE LIII.

Buffalo II.

Showing the mean daily averages, with percentages and ratios during a preliminary period of observation, of the Urine and its constituents, together with the Water drunk and Dung passed.

Periods.		Observation.	Latent Period.	Paroxysm I.	Intermission I.	Paroxysm II.	Intermission II.	Paroxysm III.	Intermission III.	Paroxysm IV.	Intermission IV.	Paroxysm V	Intermission V	Paroxysm VI.	Intermission VI.	Paroxysm VII.	Intermission VII.	*Post mortem.*	Observation.	Latent Period.	Paroxysms.	Intermission.	Whole Period.
Days.		31	5	1	2	2	4	4	1	1	9	1	8	2	4	4	3		31	5	15	31	82
	Quantity.																						
Urine	C. C.	1,040	1,594	1,980	1,710	1,725	1,780	1,597	1,890	1,185	1,486	1,350	1,500	1,827	1,485	947	908	850	1,040	1,594	1,453	1,598	1,499
Ratio	...	1	1·53	1·90	1·64	1·66	1·71	1·53	1·81	1·14	1·43	1·29	1·44	1·75	1·43	0·91	0·86	...	1	1·53	1·39	1·53	1·44
Urea	Grammes	3·211	3·211	3·560	3·330	4·240	5·490	3·630	4·720	2·720	3·858	4·450	6·700	15·170	16·630	30·870	25·860	6·035	3·211	3·190	12·50	8·57	7·01
Ratio	...	1	0·99	1·11	1·04	1·32	1·71	1·13	1·47	0·85	1·20	1·39	2·08	4·72	5·16	9·61	8·05	...	1	0·99	3·89	2·67	2·18
Hippuric Acid	Grammes	49·32	61·89	74·64	61·67	69·22	67·66	65·71	90·72	54·27	58·78	48·54	58·16	56·28	48·98	36·07	25·64	0·00	49·32	61·89	55·70	55·69	53·66
Ratio	...	1	1·25	1·51	1·25	1·40	1·37	1·33	1·84	1·10	1·19	0·98	1·17	1·14	0·99	0·73	0·52	...	1	1·25	1·12	1·13	1·08
Albumen	Grammes	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Trace	Trace	...	...	...	...	...
Total Solids	Ditto.	109·35	147·84	173·25	146·61	169·67	147·84	150·14	190·99	117·31	134·06	116·10	134·20	185·43	130·13	98·10	68·10	18·70	109·35	147·84	140·65	141·61	138·69
Ratio	...	1	1·35	1·58	1·34	1·55	1·35	1·37	1·75	1·07	1·22	1·06	1·22	1·69	1·19	0·89	0·62	...	1	1·35	1·28	1·29	1·26
Water drunk	Litres	9·26	11·09	9·09	13·41	11·25	11·02	12·84	16·82	8·18	10·88	8·41	11·66	15·12	9·14	9·43	1·02	...	9·26	11·09	10·90	10·24	10·04
Ratio	...	1	1·19	0·98	1·44	1·21	1·19	1·38	1·81	0·88	1·17	0·91	1·26	1·41	0·98	1·01	0·11	...	1	1·19	1·17	1·10	1·08
Ratio Urea / Urine	1:	323·9	499·6	556·1	513·5	406·8	324·2	440·1	413·1	435·6	385·1	303·3	223·8	120·4	89·3	30·6	34·9	140·8	323·9	499·6	116·2	186·3	213·0
Ratio Urine / Water drunk	1:	8·90	6·95	4·59	7·84	6·52	6·19	8·04	8·89	6·90	7·32	6·22	7·77	7·18	6·16	9·95	0·75	...	8·90	6·95	7·49	6·41	6·69
Ratio Water egested / „ ingested	1:	1·16	1·41	0·89	1·51	1·58	0·82	1·04	1·91	0·89	1·26	1·08	1·16	1·42	1·02	1·32	0·30	...	1·16	1·41	1·18	1·13	1·17
Dung passed	Kilos.	9·727	8·591	11·363	9·431	7·727	16·136	14·372	9·318	11·136	9·341	9·318	11·477	9·940	10·200	8·068	2·895	31·02	9·727	8·591	10·400	10·168	9·940
Ratio	...	1	0·88	1·16	0·96	0·79	1·65	1·47	0·95	1·14	0·96	0·95	1·18	1·02	1·05	0·82	0·29	...	1	0·88	1·06	1·04	1·02

TABLE LIV.

Buffalo II.

Showing the total amount of Nitrogen ingested and egested during preliminary period of observation, and the phases of Surra.

Maximum weight 177·3 and minimum 135·0 kilos.

Periods.	Number of days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	31	664·65	179·952	588·10	768·052	...	103·402	164·1
Latent Period . .	5	106·84	37·157	83·76	120·917	...	14·077	154·1
Paroxysm I . .	1	21·74	8·316	22·21	30·526	...	8·786	157·1
Intermission I .	2	39·23	14·364	36·79	51·154	...	11·924	154·1
Paroxysm II . .	2	37·82	15·438	28·40	43·838	...	6·018	156·6
Intermission II .	4	88·69	36·911	110·37	147·281	...	58·591	152·7
Paroxysm III . .	4	77·05	32·649	98·32	130·969	...	53 915	157·1
Intermission III .	1	22 22	9·639	15·93	25·569	...	3·349	156·0
Paroxysm IV . .	1	16·07	6·470	19·04	25·510	...	9·440	152·3
Intermission IV . .	9	158·36	74·916	143·79	218·706	...	60·346	150·7
Paroxysm V . .	1	17·96	7·776	15·93	23·706	...	5·746	152·4
Intermission V .	8	158·36	80·667	157·09	237·757	...	79·397	152·2
Paroxysm VI . .	2	37·82	29·089	34·00	63·089	...	25·269	150·9
Intermission VI .	4	69·96	50·707	69·76	120·467	...	50·507	145·2
Paroxysm VII .	4	58·14	70·229	55·28	125·509	...	67·369	142·2
Intermission VII .	3	6·62	41·515	9·91	51·425	...	44·807	137·4
Post mortem . .	...	...	3·162	53·05	56·211	...	...	...

TABLE LV.

Buffalo II.

Showing the total amount of Nitrogen ingested and egested in the massed periods.

Periods.	Number of days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total. Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	31	664·650	179·952	588·10	768·052	...	103·402	164·1
Latent Period . .	5	106·840	37·157	83·76	120·917	...	14·077	154·1
Paroxysms . .	15	266·604	169·967	273·18	443·147	...	176·543	152·6
Intermissions . .	31	543·438	311·881	596.69	908·571	...	365·133	149·7
Whole Period . .	82	1,581·532	698·957	1,488·68	2,187·657	...	606·105	152·2

TABLE LVI.

Buffalo II.

Showing the mean daily amount of Nitrogen ingested and egested during the preliminary period of observation, and the phases of Surra.

Periods.	Number of days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	31	21·37	5·805	18·97	24·775	...	3·335	164·1
Latent Period . .	5	21·37	7·431	16·75	24·183	...	2·815	154·1
Paroxysm I . .	1	21·74	8·316	22·21	30·526	...	8·786	157·1
Intermission I .	2	19·61	7·182	18·39	25·577	...	5·962	154·1
Paroxysm II . .	2	18·91	7·719	14·20	21·919	...	3·009	156·6
Intermission II .	4	22·17	9·227	27·59	36·820	...	14·648	152 7
Paroxysm III . .	4	19·26	8·162	24·58	32·742	...	13·479	157·1
Intermission III .	1	22·22	9·639	15·93	25·569	...	3·349	156·0
Paroxysm IV . .	1	16·07	6·470	19·04	25·510	...	9·440	152·3
Intermission IV .	9	17·75	8·324	15·97	24·300	...	6·705	150·7
Paroxysm V . .	1	17·96	7·776	15·93	23·706	...	5·746	152·4
Intermission V .	8	19·79	10·083	19·64	29·719	...	9·924	152·2
Paroxysm VI . .	2	18·91	14·544	17·00	31·544	...	12·634	150·9
Intermission VI .	4	17·49	12·677	17·44	30·116	...	12·627	145·2
Paroxysm VII .	4	14·53	17·557	13·82	31·377	...	16·842	142·2
Intermission VII .	3	2·21	13·838	3 30	17·141	...	14·936	137·4

TABLE LVII.

Buffalo II.

Showing the mean daily amount of Nitrogen ingested and egested in the massed periods.

Periods.	Number of days.	Ingested.	Egested.			Difference.		Mean body-weight.
		Total Nitrogen.	In Urine.	In Dung.	Total.	+	−	
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Kilos.
Preliminary Observation.	31	21·370	5·805	18·97	24·775	...	3·335	164·1
Latent Period . .	5	21 370	7·431	16·75	24·183	...	2·815	154·1
Paroxysms . .	15	17·773	11·331	18·21	29·543	...	11·769	152·6
Intermissions . .	31	17·530	10·061	19·25	29·308	...	11·778	149·7
Whole Period . .	82	19·287	9·524	18·15	26·678	...	7·391	152·2

BUFFALO No. II.

1,581·532 grammes Nitrogen in Hay.
1,488·680 „ „ in Dung.

92·852 „ assimilated Nitrogen.

698·957 „ Nitrogen in Urine.
92·852 „ „ assimilated.

606·105 „ „ actually lost as flesh.
42·4 ratio of Nitrogen per cent. in flesh examined.

25,698·85 Kilos flesh.
·0022

56·537470 lbs. flesh lost by Nitrogen.

Total loss in Body-weight { lbs. 374 at commencement. 297 at death. 77 lbs=35 kilos.

Loss by Nitrogen . . . . 73·42 per cent.
„ „ CO_2, Moisture, etc. . . 26·58 per cent.

On reference to the Table we observe that during the period of preliminary observation the assimilated Nitrogen was 11·51 per cent. of the total amount ingested; in the latent period this increased to 21·60 per cent., but in the massed paroxysmal and periods of intermission little or no Nitrogen was utilized at all. During the whole period the case lasted the Nitrogen assimilated was only 5·87 per cent.

TABLE LVIII.

BUFFALO II.

Showing the amount of water ingested and egested and the percentage excreted in Urine and Dung.

PERIODS.	No. of days.	Water in grass.	Water drunk.	Total ingested.	Water in Urine.	Water in Dung.	Total egested.	Difference between ingested and egested.	% Ingested water excreted as Urine.	% Excreted in Dung.
		Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.	Grammes.		
Observation . . .	31	33,939	287,045	320,984	28 854	246,874	275,728	+45,256	...	...
Mean daily . . .	...	1,094	9,259	10,354	931	7,964	8,894	1,459	8·99	76·91
Latent Period . .	5	4,366	55,454	59,820	7,231	35,115	42,346	+17,474	...	...
Mean daily . . .	...	873	11,091	11,964	1,446	7,023	8,469	3,495	12·09	58·70
Paroxysm I . . .	1	889	9,090	9,979	1,807	9,289	11,096	—1,117	...	...
Mean daily . . .	...	889	9,090	9,979	1,807	9,289	11,096	—1,117	18·11	93·08
Intermission I .	2	1,603	26,818	28,421	3,127	15,593	18,720	+9,701	...	...
Mean daily . . .	...	801	13,409	14,210	1,563	7,796	9,360	4,850	11·00	54·86
Paroxysm II . .	2	1,545	22,500	24,045	3,111	12,023	15,134	+8,911	...	...
Mean daily . . .	...	772	11,250	12,022	1,555	6,011	7,567	4,455	12·93	50·00
Intermission II .	4	3,439	44,091	47,530	6,529	51,490	58,019	—10,489	...	...
Mean daily . . .	...	859	11,023	11,882	1,632	12,872	14,504	—2622	13·73	08·33
Paroxysm III . .	4	3,239	51,363	54,602	5,790	46,644	52,434	+21,64	...	...
Mean daily . . .	...	808	12,841	13,650	1,447	11,661	13,108	541	10·60	35·42
Intermission III .	1	934	16,818	17,752	1,700	7,558	9,258	+8,494	...	...
Mean daily . . .	...	934	16,818	17,752	1,700	7,558	9,258	8,494	9·57	42·57
Paroxysm IV . .	1	675	8,181	8,856	1,068	8,863	9,931	—1,075	...	...
Mean daily . . .	...	675	8,181	8,856	1,068	8,863	9,931	—1,075	12·05	100·07
Intermission IV .	9	5,870	97,954	103,824	14,941	66,923	81,864	+21,960	...	...
Mean daily . . .	...	652	10,883	11,536	1,660	7,436	9,096	2,440	14·38	64·45
Paroxysm V . . .	1	661	8,409	9,070	1,234	7,558	8,792	+278	...	...
Mean daily . . .	...	661	8,409	9,070	1,234	7,558	8,792	278	13·60	83·32
Intermission V .	8	6,268	93,295	99,563	10,926	74.446	85,372	+14,191	...	...
Mean daily . . .	...	783	11,662	12,445	1,366	9,305	10,671	1,774	10·97	74·76
Paroxysm VI . .	2	1,452	26,250	27,702	3,284	16,122	19,406	+8,296	...	...
Mean daily . . .	...	726	13,125	13,851	1,642	8,061	9,703	4,148	11·85	58 18
Intermission VI .	4	2,770	86,591	39,361	5,418	33,077	38,495	+866	...	...
Mean daily . . .	...	692	9,148	9,840	1,354	8,269	9,623	216	13·76	84·03
Paroxysm VII . .	4	1,499	37,727	39,226	3,398	26,166	29,564	+9,662	...	...
Mean daily . . .	...	375	9,431	9,806	849	6,541	7,391	2,415	8·65	66·70
Intermission VII .	3	171	2,045	2,216	2,505	4,698	7,203	—4,987	...	...
Mean daily . . .	...	57	682	739	835	1,566	2,401	—1,662	86·46	210·19

TABLE LIX.

Buffalo II.

Showing the percentages of ingested Water excreted as Urine in the Dung and by the Lungs and Skin.

Periods.	Length, in days.	Urine.	In Dung.	Lungs, Sweat, etc.	Total.
		%	%	%	
Observation	31	8·99	77·91	13·10	100
Latent Period	5	12·09	58·70	29·21	100
Paroxysm I	1	18·11	93·08	*	...
Intermission I	2	11·00	54·86	34·14	100
Paroxysm II	2	12·93	50·00	38·07	100
Intermission II	4	13·73	108·33	*	...
Paroxysm III	4	10·60	85·42	3·98	100
Intermission III	1	9·57	42·57	47·86	100
Paroxysm IV	1	12·05	100·07	*	...
Intermission IV	9	14·38	64·45	21·17	100
Paroxysm V	1	13·60	83·32	3·08	100
Intermisson V	8	10·97	74·76	14·27	100
Paroxysm VI	2	11·85	58·18	29·97	100
Intermission VI	4	13·76	84·03	2·21	100
Paroxysm VII	4	8 65	66·70	24·65	100
Intermission VII	3	86·46	210·19	*	...

* Egested water exceeded ingested.

TABLE LX.

Buffalo II.

Showing the percentage of dry matter digested during a preliminary period of observation, and the phases of Surra.

Periods.		Total dry matter ingested.	:	100	: :	Total dry matter digested.	:	% Dry matter digested in different periods.
		Kilos.				Kilos.		
Observation	As	125·833	:	100	: :	70·702	:	56·18
Latent Period	„	21 316	:	100	: :	13·464	:	63·16
Paroxysm I	„	4·339	:	100	: :	2·262	:	52·13
Intermission I	„	7·829	:	100	: :	4·381	:	55·95
Paroxysm II	„	7·545	:	100	: :	4·886	:	64·75
Intermission II	„	16·788	:	100	: :	4·989	:	29·71
Paroxysm III	„	15·374	:	100	: :	4·863	:	31·63
Intermission III	„	4·433	:	100	: :	2·729	:	61 56
Paroxysm IV	„	3·227	:	100	: :	1·191	:	36·90
Intermission IV	„	31·799	:	100	: :	16·427	:	51·63
Paroxysm V	„	3·607	:	100	: :	1·903	:	52·76
Intermission V	„	31·799	:	100	: :	14·427	:	45·37
Paroxysm VI	„	7·594	:	100	: :	3·831	:	50.45
Intermission VI	„	14·048	:	100	: :	6·329	:	45·05
Paroxysm VII	„	12·477	:	100	: :	6·371	:	51·06
Intermission VII	„	1·420	:	100	: :	0·323	:	22·74

TABLE LXI.

Buffalo II.

Showing the percentage of dry matter digested during massed periods.

Periods.		Total dry matter ingested.	:	100	: :	Total dry matter digested.	:	% Dry matter digested in different periods.
		Kilos.				Kilos.		
Observation . .	As	125·833	:	100	: :	70·702	:	**56·18**
Latent Period . .	,,	21·316	:	100	: :	13·464	:	**63·16**
Paroxysms . .	,,	54·163	:	100	: :	25·307	:	**46·72**
Intermissions . .	,,	108·116	:	100	: :	49·605	:	**45·88**
Whole Period . .	,,	309·428	:	100	: :	153·749	:	**49·68**

	Kilos.	
Total Hay eaten =	378·698	
Less H_2O =	69·270	
	309·428	Total dry matter ingested.
Total Dung =	843·811	
Less H_2O =	688·132	
	155·679	Dry Dung.
Total dry matter ingested =	309·428	
„ „ „ egested =	155·679	
Dry matter digested =	153·749	

As 309·428 : 100 : : 153·749 : **49·68** per cent. Dry matter digested for whole period.

TABLE LXII.

Buffalo II.

Showing the mean daily number of the different blood corpuscles in 1 c. mm., with the ratios to one another, together with the percentage of Hæmoglobin, during a period of observation and disease (Surra).

Periods.	Hæmatozoa.		Hæmoglobin.	Red Corpuscles.	White Corpuscles.	Coarsely granular corpuscles.	Hæmatozoa.	Ratio White to Red Corpuscles.	Ratio Coarsely Granular Corpuscles to White Corpuscles.	Ratio Coarsely Granular Corpuscles to Red Corpuscles.	Number of days.
	Maximum.	Minimum.		in 1 c. mm.							
Observation .	...	...	100	8,285,150	11,875	2,666	...	1 : 697	1 : 4·4	1 : 3,107	33
Latent Period .	...	...	100·5	8,302,000	16,200	3,900	...	1 : 512	1 : 4·1	1 : 2,138	5
Paroxysm I .	F.	F.	100	8,500,000	38,500	3,500	50	1 : 220	1 : 11·0	1 : 2,428	1
Intermission I .	...	..	100	8,360,000	27,250	3,750	...	1 : 306	1 : 7·2	1 : 2,229	2
Paroxysm II .	S.	S.	99	8,345,000	20,250	750	63,500	1 : 412	1 : 27·0	1 : 11,126	2
Intermission II	...	...	98	8,245,000	21,000	2,875	...	1 : 392	1 : 7·3	1 : 2,868	4
Paroxysm III .	N.	F.	95	8,192,500	20,500	2,000	1,375	1 : 399	1 : 10·2	1 : 4,096	4
Intermission III .	...	...	98	8,260,000	21,500	2,500	...	1 : 384	1 : 8·6	1 : 3,304	1
Paroxysm IV .	F.	F.	96	8,180,000	18,500	1,000	500	1 : 442	1 : 18·5	1 : 8,180	1
Intermission IV .	...	...	95	8,024,440	20,666	3,389	...	1 : 388	1 : 6·0	1 : 2,368	9
Paroxysm V . .	F.	F.	87	7,650,000	15,000	2,000	5	1 : 510	1 : 7·5	1 : 3,825	1
Intermission V .	...	...	81	7,286,250	20,812	4,687	...	1 : 350	1 : 4·4	1 : 1,554	8
Paroxysm VI .	F.	F.	81	7,450,000	16,500	2,000	500	1 : 451	1 : 8·2	1 : 3,725	2
Intermission VI .	...	...	76	7,280,000	24,625	4,625	...	1 : 295	1 : 5·3	1 : 1,574	4
Paroxysm VII .	F.	F.	76	7,105,000	23,125	4,375	500	1 : 307	1 : 5·2	1 : 1,624	4
Intermission VII	...	...	76	7,470,000	22,500	4,750	...	1 : 332	1 : 4·7	1 : 1,572	2

TABLE LXIII.

Buffalo II.

Showing the mean daily number of the different blood corpuscles in 1 c.mm., with the ratio to one another, together with the percentage of Hæmoglobin for the periods massed together.

Periods.	Hæmoglobin.	Red Corpuscles.	White Corpuscles.	Coarsely granular Corpuscles.	Hæmatozoa.	Ratio White to Red Corpuscles.	Ratio Coarsely Granular Corpuscles to White Corpuseles.	Ratio Coarsely Granular Corpuscles to Red Corpuscles.	Number of days.
		in 1 c.mm.							
Observation .	100	8,285,150	11,873	2,666	...	1 : 697	1 : 4·4	1 : 3,107	33
Latent Period .	100·5	8,302,000	16,200	3,900	...	1 : 512	1 : 4·1	1 : 2,128	5
Paroxysms .	90·6	7,806,660	21,330	2,500	4,762	1 : 366	1 : 8·5	1 : 3,122	15
Intermissions .	90 6	7,751,000	21,940	3,920	...	1 : 354	1 : 5·5	1 : 1,979	31
Whole Period .	91·75	8,006,750	17,480	3,163	...	1 : 458	1 : 5·5	1 : 2,531	84

TABLE LXIV.

Buffalo II.

Showing the percentage of Corpuscles in the massed periods, taking the number in the observation as 100.

Periods.	Hæmoglobin.	Red Corpuscles in 1 c. mm.	White Corpuscles in 1 c. mm.	Coarsely Granular Corpuscles in 1 c. mm.
Observation . .	100	100	100	100
Latent Period . .	100·5	102	136·4	104·2
Paroxysms . .	90·6	94·2	179·6	93·8
Intermissions . .	90·6	93·5	184·8	104·7
Whole Period . .	91·75	96·6	147·2	101·8

Corpuscular Changes in the Blood.

Red Corpuscles.—A slight increase occurred in the latent period equal to a mean of 2 per cent. During the paroxysms there was a decrease of 5·8 per cent. in their number and a still further decrease during the intermissions, while for the whole period the loss was 3·4 per cent.

White Corpuscles.—There was a 36·4 per cent. rise in their number during the latent period, which was still further added to in the paroxysms; but the maximum increase, 8·48 per cent., was attained in the intermissions.

Coarsely Granular Oxyphile Cells.—Taking the mean daily number during the period of observation as 100, there was an increase of 4·2 per cent. in the latent period, but a fall of 6·2 per cent. during the paroxysms. As soon as the organisms disappeared from the circulation, and the temperature of the body fell to normal during the intermissions, a rise in coarsely granular cells took place.

Hæmoglobin.—Co-existent with the slight rise in number of the red corpuscles during the latent period, the Hæmoglobin percentage increased 0·5 above that found during the period of observation, but during the paroxysms and intermissions there was a fall of nearly 10 per cent.

Remarks comparing the results obtained in the cases of Buffaloes I and II.

Two buffaloes, No. I, weighing 359 lbs., and No. II, 374 lbs., appeared in perfect health and condition; both animals were fed on hay only. The period of observation in the former animal was 14 days, and in the latter 31. The animals were occasionally allowed to walk about the yard, but were given no regular exercise. The quantity of urin excreted during the period of observation was in the case of No. I, 1,250 c.c., in No. II, 1,040 c.c.; there was a marked decrease in the former case in the latent period and paroxysms, until in the intermissions the daily average was only 912 c.c. In the case of No. II exactly the reverse conditions existed; there was an increase of 50 per cent. in the latent period, which was also maintained in the paroxysms and intermissions.

Urea.—Buffalo No. I, excreted in the observation period an average of 2·98 grammes of urea daily, and No. II, 3·21 grammes daily. During the latent period there was an average daily, loss in the former animal, as compared with the period of observation, whilst in the latter animal that average was maintained. During the paroxysms the amount excreted exceeded that of the period of observation by 92 per cent. in No. I and 258 per cent. in No. II. During the intermissions in No. I there was still an excess of 45 per cent. over that excreted in the observation, and 167 per cent. in No. II. For the whole period extending in No. I, 139 days, and in No. II, 82 days, the excess was 63 per cent. and 118 per cent., respectively.

The ratios for the different periods in each case, observation being taken as I, were :—

Animals.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo I	1	0·74	1·92	1·45	1·63
„ II	1	0·99	3·58	2·67	2·18

Hippuric Acid.—With regard to Hippuric Acid in Buffalo No. I, the excretion continued during the whole case; the quantity was somewhat reduced during the latent period, but the minimum was attained during the paroxysms; on the contrary, in Buffalo No. II, there was an increase of 25 per cent. in the latent period, and half this amount during the paroxysms and intermissions.

The ratios for the different periods in each case, observation being taken as 1, were :—

Animals.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo I	1	0·97	0·79	0·81	0·83
„ II	1	1·25	1·12	1·13	1·08

Further attention may be drawn to the ratio of Urea to Hippuric Acid existing in the two cases. The following table will show the ratio of one to the other during the different periods :—

Animals.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo I	1 : 18	1 : 23·7	1 : 7·4	1 : 10·1	1 : 9·2
„ II	1 : 15	1 : 19·4	1 : 4·4	1 : 6·4	1 : 7·6

Albumen.—No albumen was passed by either of the two animals during the period of observation or during the phases of the disease.

Water.—Although the animals were practically the same weight, No. I drank 5·47 litres and No. II 9·26 litres daily, in the observation, and for the whole period No. I drank 40 per cent. less than No. II.

The table shows the difference in the percentage of water drunk by the two animals :—

Animals.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo I	0·59	0 63	0·70	0·76	0·67
„ II	1	1·19	1·17	1·10	1·08

Another marked point of difference between these two animals was in the ratio of total water ingested to the body-weight. In No. I in the observation it was about 1 : 32·5, and just before death as 1 : 23·2; whereas in No. II the ratios were 1 : 16·8 and 1 : 66, respectively. The total loss of body-weight in the two animals at the time of death was No. I, 25·32 per cent., and No. II, 20·58 per cent.

Total Solids in Urine.—Buffalo No. II averaged much less total solids daily than Buffalo No. I; in fact the ratios are diametrically opposite.

The ratios for the different periods in each case, observation being taken as 1, were :—

Animals.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo I	1	1·35	1·28	1·29	1·26
„ II	1	0·72	0·72	0·69	0·72

Dung.—Buffalo I passed about 50% less dung in the observation period than No. II.

The ratios of amount of dung passed during the different phases of the disease were as follows:—

Animals.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo I	1	0·92	1·28	1·27	1·25
Buffalo II	1	0·88	1·06	1·04	1·02

Temperature.—These experiments were carried out during the months November—March at an elevation of 7,500 feet. The temperature varied as follows:—

Animals.	Length of Case.	Temperature °Fahrenheit.					
		Maximum.			Mean.		
		A. M.	Noon.	P. M.	A. M.	Noon.	P. M.
Buffalo I . . .	139	59·0	67·5	61·5	47·1	53·8	49·5
Buffalo II . . .	82	55·75	64·5	59·0	44·3	51·2	48·3

Lowest Temperature registered during				November	47° F.
,,	,,	,,	,,	December	36° F.
,,	,,	,,	,,	January	36° F.
,,	,,	,,	,,	February	38° F.
,,	,,	,,	,,	March	49° F.

TABLE LXV.

Showing the chief facts connected with the undermentioned animals during the different periods of observation and disease (Surra) massed together.

	I					II					III					IV					V					VI				
	Body-weights at different periods of observation and disease in lbs.					Length of different periods, in days.					Body Temperatures, Maximum and Minimum, during each period, °C.					Average daily Urine. C.C.					Average daily Urea, in grammes.					Mean daily amount of dung passed in different periods, in lbs.				
	Observation.	Latent Period.	Weight at death.	Total loss.	Mean daily loss in Paroxysms and Intermissions.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo No. I	359	358	267	92	0·75	14	5	39	81	139	38·3 36·0	38·0 36·4	39·5 35·1	39·0 35·2	39·5 35·1	1,250	987	982	912	1,004	2·98	2·21	5·74	4·33	4·87	13·64	12·65	18·02	17·35	17·07
„ II	374	339	297	77	0·91	31	5	15	31	82	39·2 35·0	38·4 36·0	40·0 36·0	39·0 36·0	40·0 35·0	1,040	1,594	1,453	1,198	1,499	3·21	3·19	12·50	6·57	7·01	21·40	18·90	22·88	22·37	21·88
Bull No. V	287	247	...	...	...	72	6	8	15	101	39·4 36·0	38·8 37·1	41·5 37·4	39·5 37·0	41·5 36·0	683	641	480	472	569	2·88	2·96	4·03	3·66	3·07	14·15	9·91	9·44	11·47	13·12

	VII					VIII					IX					X					XI				
	Average daily water drunk in different periods, in Litres.					Difference between Nitrogen ingested and egested, in Grammes.					Ratio of Urea to Urine. /:					Ratio of Urine to Water-drunk. /:					Ratio of total Water egested to ingested. /:				
	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.	Observation.	Latent Period.	Paroxysms.	Intermissions.	Whole Period.
Buffalo No. I	5·47	5·90	6·54	7·03	6·23	+142·858	+24·290	−224·449	−325·057	−382·358	419	446	171	210	206	4·37	5·98	6·66	7·70	6·20	1·15	1·28	1·00	1·06	1·12
„ II	9·26	11·09	10·90	10·24	10·04	−103·402	−14·077	−176·543	−365·133	−606·105	323·9	499·6	116·2	186·3	213·0	8·90	6·95	7·49	6·41	6·69	1·16	1·41	1·18	1·13	1·17
Bull No. V	6·55	3·92	4·82	4·98	5·07	−53·509	−8·344	−15·654	−34·694	−112·200	239	217	125	124	176	9·59	6·11	10·32	11·05	9·27	1·28	1·03	1·35	1·22	1·22

SUMMARY OF CORPUSCULAR CHANGES IN THE BLOOD OF BOVINES AND BUFFALOES.

The changes observed with regard to the number of red, white and coarsely granular oxyphile cells in the blood, when Surra was transmitted by inoculation, are as follows :—

Red Corpuscles.

An increase in the number of red corpuscles occurred in the latent period, equal to 6·2 per cent. in the Bull, and 4 and 2 per cent., respectively, in the Buffaloes. During the paroxysms there was a decrease of 5·3 in the former animal, and 13·6 and 5·8 per cent., respectively, in the latter animals. A further slight decrease occurred in the intermissions, most marked in the Bull.

TABLE LXVI.

Showing the percentages of Red Corpuscles, taken on the mean daily number in the blood of the Bull and Buffaloes, during different periods of observation and disease (Surra).

Periods.	Length in days.	Bull No. V.	Length in days.	Buffalo No. I.	Length in days.	Buffalo No. II.
Observation	72	100·0	14	100·0	33	100·0
Latent Period	6	106·2	5	104·0	5	102·0
Paroxysms	8	94·7	39	86·4	15	94·2
Intermissions	15	92·9	81	85·4	31	93·5
Whole Period	101	98·6	139	93·9	84	96·6

White Corpuscles.

An increase of 23·3 per cent. in the number of white corpuscles took place during the period of incubation in Bull V. In Buffalo I there was a decrease of 5·9, but in Buffalo II an increase of 36·4 per cent. occurred. During the paroxysms a slight increase, compared with that observed during the periods of observation, was registered in the case of the Bull and Buffalo I, but in the third animal the white corpuscles were augmented to the extent of 79·6 per cent.

The Bull during the absence of the hæmatozoon from the circulation (intermissions) regained some of its lost ground; for the massed periods show a decrease of 9·9 per cent. in the number of white corpuscles present compared with the observation period. The Buffaloes, on the other hand, showed an increase of 13·5 and 84·8 per cent., respectively. The length of paroxysms, compared with the intermissions in the case of the Bull, was as 1 : 1·87, and in the Buffaloes as 1 : 2·07 and 1 : 2·06, respectively.

TABLE LXVII.

Showing the percentages of White Corpuscles, taken on the mean daily number in the blood of the Bull and Buffaloes, during different periods of observation and disease (Surra).

Periods.	Length in days.	Bull No. V.	Length in days.	Buffalo No. I.	Length in days.	Buffalo No. II.
Observation	72	100·0	14	100·0	33	100·0
Latent Period	6	123·3	5	94·1	5	136·4
Paroxysms	8	108·5	39	103·2	15	179·6
Intermissions	15	90·1	81	113·5	31	184·8
Whole Period	101	105·5	139	102·7	84	147·2

Coarsely Granular Oxyphile Cells (Eosineophile Corpuscles).

In the case of the Bull an increase of 45·6 per cent. took place during the latent period, but in the Buffaloes the augmentation was only 8·1 and 4·2 per cent., respectively. During the paroxysms and intermissions the numbers decreased in the Bull, increased in Buffalo I, until the numbers in the intermission were double those of the period of observation, while in the third animal there was a well-marked fall in the percentage of corpuscles during the paroxysms, and a gain of 10 per cent. in the intervals.

TABLE LXVIII.

Showing the percentages of Coarsely Granular Oxyphile Cells, taken on the mean daily number in the blood of the Bull and Buffaloes, during different periods of observation and disease (Surra).

Periods.	Length in days.	Bull No. V.	Length in days.	Buffalo No. I.	Length in days.	Buffalo No. II.
Observation	72	100·0	14	100·0	33	100·0
Latent Period	6	145·6	5	108·1	5	104·2
Paroxysms	8	127·1	39	121·1	15	93·8
Intermissions	15	118·4	81	200·3	31	104·7
Whole Period	101	122·6	139	132·3	84	101·8

Comparison between the Corpuscular Changes observed in the blood of Equines, Bovines, Buffaloes, etc., during a period of observation, and the phases of Surra.

If the percentages of the different corpuscles present in the blood of Bovines and Buffaloes in the massed periods of Surra be compared with similar returns recorded in equines* (horse and mule), it will be seen—

(*i*) That like results were noted in all the animals with regard to the percentage of red corpuscles present during the phases of the disease, *i.e.*, an augmentation in the number of red corpuscles during the latent period, as compared with the number registered in the period of observation, followed by a diminution in the paroxysms, which was still more marked in the intermissions.

(*ii*) In the case of the white corpuscles, during the latent period, a diminution varying from 8·8 to 25·4 per cent. took place in the equines, and 5·9 per cent. in Buffalo I, but in the blood of Bull V and Buffalo II an increase occurred in the number of corpuscles equal to 23·3 and 36·4 per cent. respectively. During the paroxysms and intermissions there was a general increase in the number of white cells, varying from 0·69 to 84·8 per cent. in all the animals with the exception of Bull V, and in this case a diminution equivalent to nearly 10 per cent. was noted during the intermission.

(*iii*) With regard to the percentages of the coarsely granular cells in the equine, bovine and buffalo species, a considerable difference has to be recorded, *viz.*, a general diminution in the number of corpuscles in the horse and mule during the different phases of the disease, latent period, paroxysms and intermissions, whereas with one exception (Buffalo II, paroxysms) there was a marked increase in the number of Eosineophile cells in the buffaloes and the bull during analogous periods.

Another point of considerable interest is that whereas the above mentioned corpuscles are absent from the blood, in the great majority of instances, at the time of death or some days before, in buffaloes their number is augmented to three or four times that noted during health. The same marked increase in the number of Eosineophile cells is also observed in bovines during the course of the disease, but in India up to the present these animals have not been observed to succumb to uncomplicated Surra.

During the course of Surra in the guinea-pig, a gradual diminution in the number of the red, white and Eosineophile corpuscles was observed to take place in the latent period, paroxysms and intermissions, with the exception that during the latter massed periods there was a slight recrudescence in the number of coarsely granular cells, but the percentage even then was less than half that noted in health.

In the following table the percentages of the coarsely granular cells noted in equines and guinea-pigs are placed side by side for reference with those obtained in buffaloes and Bull V:—

TABLE LXIX.

Periods.	Horse No. 89.	Mule I.	Mule II.	Guinea Pig.	Bull V.	Buffalo I.	Buffalo II.
Observation	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Latent Period	72·67	86·30	65·81	58·04	145·60	108·10	104·20
Paroxysms	41·12	14·78	39·52	23·26	127·10	121·10	93·80
Intermissions	82·58	12·16	56·55	47·39	118·40	200·30	104·70
Whole Period	63·89	33·27	63·60	35·87	122·60	132·30	101·80

* *Vide* Annual Report 1896-97.

NOTES CONCERNING SURRA IN BOVINES AND BUFFALOES.

Although horses which contract Surra by inoculation with the hæmatozoon of the Rat (*Mus decumanus*) succumb within a limited number of hours to a very virulent form of the disease, bovines suffering from the same malady derived from a similar source pass through a varying number of short paroxysms and prolonged intermissions, and concurrently become considerably emaciated. Eventually, after some months, these animals throw off the disease, and again attain a robust condition of body.

2. Surra in bovines appears to follow an identical course and present the same symptoms, whether the affected animals be stationed in the plains or at elevations of 1,800 feet and 7,500 feet above sea-level.

3. It would appear that the blood of bovines, after inoculation with the Surra *Trypanosoma*, must contain for a considerable period the organism or its immature form. For guinea-pigs inoculated with the blood from an animal (Bull I), on the 76th and 154th days of an intermission, respectively, succumbed to the disease, although no hæmatozoa could be discovered in the inoculated blood. Animals of the same species succumbed after passing through a period of incubation lasting 14 days when inoculated with blood from an animal (Bull III), taken on the 18th day of an intermission.

4. Bovines when inoculated with blood containing the Surra *Trypanosoma*, primarily derived from either the horse or rat, present during a varying period (5 to 14 days) a considerable amount of swelling and œdema, with tenderness at the seat of the injection. On re-inoculation, however, with material derived from either of the above sources, no local manifestations are observed to follow the operation.

5. During the case of Bull No. III, inoculated on the first occasion with horse Surra blood and on the last with material primarily derived from the rat but passed through the horse, the seat of inoculation became very irritable on the day previous to the occurrence of the II and III paroxysms. An observer, therefore, was able to recognise when the Surra organism was about to re-appear in the blood of the animal.

6. Buffaloes when inoculated with the *Trypanosoma Evansi* contract Surra after a period of incubation lasting five days, and finally succumb to the disease after passing through a varying number of paroxysms and intermissions occupying between 46 and 120 days.

APPENDIX III B.

INVESTIGATIONS REGARDING THE PRESENCE OF THE "TRYPANOSOMA."

(1) During the hot season.

In a demi-official letter dated May 15th, 1896, Veterinary-Lieutenant Loughlin, Superintendent, Civil Veterinary Department, North-Western Provinces and Oudh, informed me that his Veterinary Assistants on the Saharanpur-Mussoorie Dâk line reported the existence of Surra affecting the ponies under their charge.

This information I considered to be of the utmost importance, for during six years, with one exception (Bombay), Surra had always been found to be a disease of the rainy season, its effects being prolonged to the end of the following December or January. Here an opportunity was offered of investigating the truth of the assertion as to the existence of the above disease during the hot season of the year, and at the same time of submitting to microscopical examination the water, mud, flies and fish obtained from the immediate locality of the infected and other areas.

On May 30th I proceeded to Saharanpur, and on June 3rd accompanied Veterinary-Lieutenant Loughlin and police Superintendents Fitzgerald (Saharanpur) and Thomson (Dehra Dun) in their inspection of the animals on the Dâk line, as well as in their choice of new sites for stables at Tunbara, Landibara and Asarori in the Mohand Pass.

The horses, especially those above Mohand, presented general congestion of the conjunctivæ, due to irritation caused by the heat and dust (fine girt) especially the latter. Some animals had light red-coloured petechiæ invading the conjunctivæ, others small patches of yellow caseous material or kunker imbedded in their membranes, but in none were yellow or orange-coloured staining of the tissues observed. The limbs and under-surface of the abdomen were entirely free from œdema and swellings due to the accumulation of gelatinous material in the subcutaneous tissues as observed in animals, the subjects of Surra.

The blood of about 150 Dâk animals was submitted to microscopical examination, but in none was the Surra *Trypanosoma* found.

The following horses submitted by the Veterinary Assistants as suspected cases of Surra were the subjects of either light-red conjunctival petechiæ or had a rise of body temperature. Microscopical examination of the blood revealed the following results :—

TABLE LXX.

Serial No.	Animals No.	Colour.	Owner's name.	Stable.	Surra Hæmatozoa.	Filaria Papillosa.	Remarks.
1	45	Chestnut	Lalta Persad	Mohand	Absent	Absent	Bursati sore.
2	41	Brown	Asgar Ali	„	„	„	The temperature, pulse and respiration were taken and blood examined for four days.
3	40	Grey	Ditto	„	„	„	
4	169	Dark brown	Hossein	„	„	„	
5	43	Brown	Ditto	„	„	„	
6	42	Bay	Asgar Ali	„	„	„	Bursati sore.
7	41	Dunn	Lalta Persad	„	„	„	Ditto
8	30	Black	Rooknudin	„	„	„	Ditto
9	28	Bay	Ditto	„	„	„	Ditto
10	46	Roan	M. Hossein	Landibara and Tunbara.	„	„	Temperature 103·9°F.
11	45	Grey	Asgar Ali		„	Present	3 Filaria in specimens.
12	48	Dark grey	Lalta Persad		„	Absent	...
13	33	Grey	R. D. Khan		„	Present	5 in first specimen, 9 in second specimen.
14	35	Bay	Ditto		„	Absent	...

Examined blood microscopically on three occasions.

The opinion of a Syce with 17 years' experience, with regard to whether the suspected cases on the Mussoorie Dâk line were Surra, is worth recording. He said: "These cases are not Surra; the bad eyes are caused by the heat and dirt. The skins of Surra animals get so hot we cannot touch them, the eyes get yellow, the limbs and under surface of the belly swell and the animals do not only pass much water but eat more and more until we get tired of feeding them. The horses get thin, walk in a zig-zag, and then die."

As early as 1891, I was able to demonstrate the presence of the Surra parasite in the blood of certain flies* caught near to or on the bodies of animals (horses, bovines, dogs) suffering from that disease, and also observed three varieties of organisms, resembling somewhat those of the Surra parasite in the blood of certain species of fish, members of the three following families and genera, taken from rivers in the Deccan, on the West Coast of India :—

(*a*) *Rhynchobdellidæ.*
Genera, (*I*) *Rhynchobdella*—sp. *R. Aculeata.*
(*II*) *Mastacembelus*—sp. *M. Armatus.*
(*b*) *Cyprinidæ.*
Genus, *Barbus* —sp. *B. Carnaticus.*
(*c*) *Ophiocephalidæ.*
Genus, *Ophiocephalus* —sp. *O. Striatus.*

* Nawab Khan, the camel jemadar of the 3rd Punjab Infantry, has the reputation of knowing more about camels than any body else in the District, and he communicated to me the following information, as interpreted by Major Money, 4th Punjab Cavalry :—

"The prevailing opinion among the natives in this district is that *surra* is caused by the bite of a large brown fly (the size of a small bee) called *bhura dhang*. In the month of May that fly comes from the ground in jungle-land that has been under water. In June and July the flies are very numerous and in full force; about the 15th August they begin to diminish, and early in October they are obtained with difficulty. The fly bites horned cattle and donkeys, but they suffer no ill effects; it bites men, and a painful swelling follows; it bites horses and camels, and gives them a fatal disease known by several names, such as *Khauhog doaia* and *Surra*, depending upon the several stages. *Phipri* is another name by which it is known among camels. I know of no reason for saying that the fly causes the disease except the common tradition of my people."

Report on 'Surra' disease—G. Evans, Esq., M.D., Inspector, Veterinary Surgeon, British Army, dated 13th November 1880.

Kay-Lees has attributed to the Tse-tse, but without sufficient proof, the mortality occurring among Horses and Mules of the English Army in Northern India.

Kay-Lees—Glossina Morsetenes, or Tse-tse Fly, Veterinary Journal, XXVI, 1888, page 79.

In the forest regions of Korea insect pests abound in the summer months. Mosquitoes, gnats and gad-flies make the lives of the settlers perfectly burdensome for two or three months of the year, and *ponies* and *bulls* quickly succumb to their attacks. The houses are kept constantly filled with birch smoke to drive them off; cattle are protected by fires of green wood in the open, and men working the clearings carry coils of rope made from dried *artemesia*, which burns slowly and emits a pungent odour, for the same purpose.

Campbell, C. W.—*A Journey through North Korea, etc., 1892.*

The question which then presented itself for solution was whether the *Trypanosoma* is ever to be found in stagnant or other waters, in the body fluids of flies, ticks or fish (i) during the hot season of the years, when no cases of Surra exist. (ii) during the early part of the rains before the disease has manifested itself in animals? Since 1891, I have diligently searched during each season of the year to discover whether the *Trypanosoma* is present under any of the above conditions. One point has been settled, *viz.*, that the organisms in the blood of certain fish are present in greatest numbers, during May and June, the hottest months of the year, but decrease or absent themselves after the rains have fairly set in.

Since the transference of the Laboratory from the Deccan to Muktesar within easy reach of the North-Western Provinces and Punjab, the home of Surra, where each year opportunities are forthcoming for studying the etiology of the disease, I determined to thoroughly investigate this question. In order to elucidate the above problem it would be necessary to visit the localities known to be Surra centres—during the hot season, but just before the rains usually commence—at the end of May and beginning of June—and a second time about the end of August or beginning of September—the middle of the rains—and on each occasion to systematically make a very large number of microscopical observations of the different fluids to be examined. With this end in view, I proceeded at the end of May to the following localities, where outbreaks of Surra were known to have existed in in 1894 and 1895, and had probably been enzootic for many years previous to being diagnosed, *viz.*:—

Saharanpur, North Western Provinces; Mohand Pass, North-Western Provinces; and Karnal, Punjab; and Kathgodam, Kumaun.

The following are the results of my hot season observations :—

Saharanpur Government Depôt.

Microscopical examination of the water, mud, fresh water shell fish, and flies obtained from the following localities, failed to reveal the presence of any form of *Trypanosoma*.

Samples of *Water* submitted to examination—

(*i*) Modipore pond to the right of the brick-yard; water replenished after April 1896.

(*ii*) Modipore pond to the left of the brick-yard, contains water from the rains of 1895.

(*iii*) Large pond in paddock near the Depôt residencies.

(*iv*) Clay from centre of pond to the left of road to the south-east of the Depôt Estate.

(*v*) Clay from centre of pond to the right of road to the south-east of Depôt Estate.

Flies.—Numerous specimens of the thoracic and abdominal fluids of the following species of flies were submitted to microscopical examination, but with negative results :—

(*i*) Large green-headed fly (*Tabanus lineola*).

(*ii*) Large brown-headed fly (*Tabanus ?*).

(*iii*) Horse and cattle fly (*Hippobosca*).

(*iv*) Fly infesting dogs, small variety (*Hippobosca*).

(*v*) Local varieties of the *Muscidæ*.

(*vi*) Musquitoes (*Culicidæ*).

Mohand Pass.

Water.—Samples for examination were obtained from all possible sources. The Mohand River was almost dry, the Dâk horses being watered at holes in the river bed which had been excavated for the purpose of collection.

Fish.—A few small fish were obtained from water holes and their blood submitted to examination.

Flies.—Numerous species were netted and examined.

Fresh specimens and samples of the above were obtained during four days, but in no instance was the *Trypanosoma* discovered.

Karnal, Punjab.

Water—Samples of water obtained from the following sources were submitted to microscopical examination :—

(*i*) *Dâk Bungalow.*—Closed well in the compound. Water milky, with an odour of sulphuretted hydrogen.

(*ii*) *Western Jumna Canal.*—Water muddy, no flagellated protozoa.

(*iii*) *Several stagnant ditches.*—Numerous forms of organic life. No. flagellated protozoa.

Water obtained from within Depôt Estate.

(*iv*) *Pond near Canal Bridge.*—Water has been let into this pond lately from Rajbaha. No flagellated protozoa. Numerous specimens of the mud taken from the bottom of the pond were also examined for the *Trypanosoma*, but with negative results.

(*v*) *Swamps to the left of the Railway crossing*, near Bullock Hospital.

(*vi*) *Ditch near main road leading to Canal Bridge.*

(*vii*) *The swamp in No. II Paddock.*

(*viii*) *Well in No. II Paddock.*—Water fairly clear. No sediment. Few infusoria.

(*ix*) *The swamp in No. V Paddock.*—Very rich in low organic life, but no flagellated protozoa. A species of 'acarus' was found in this water.

(*x*) *The swamp in No. III Paddock.*—Evidently the swamp has been dry for sometime and the water examined is part of the rain which fell on June 5th. No flagellated organisms.

(*xi*) *Well in No. VII Paddock.*—Water fairly clear. Slight sediment. Few infusoria.

It is needless to enumerate the numerous forms of infusoria and organic life observed in the different waters submitted to microscopical examination. Suffice it to state that no *Trypanosoma* were discovered.—

Flies.—Numerous specimens comprising some eight different species were submitted to examination.

(*i*) Those caught on different animals, horses, mules, bullocks, dogs.

(*ii*) Those caught in the vicinity of water, swamps, etc.

The *Trypanosoma* was not observed in any of the body fluids examined.

Ticks.—Ixodes from several animals were submitted to examination with negative results.

Fish.—A distinction with regard to the presence of hæmatozoa had been previously observed between fish inhabiting the bottom of ponds and rivers (mud-fish) and those which occupy the water above the mud. After microscopically examining the blood of a few of the latter in which few or no hæmatozoa were found, our attention was devoted to the examination of mud-fish. For the purpose of comparison examples of the following fish when possible were obtained (*i*) from the Western Jumna Canal, running water; (*ii*) the pond near the Canal Bridge (Depôt Estate), stagnant water; (*iii*) from the old River Jumna at Niawal, back water.

The results of the microscopical examination of the fish examined are as follows:—

*Cachri** or *Chăchări* (Punj).—This fish belongs to the order *Acanthopterygii*; family, *Labyrinthici*; genus *Trichogaster*. It corresponds closely with the species *T. Faciatus*.

Many specimens were caught in ponds supplied with water from the River Jumna. These presented alternate blue and yellow bands descending obliquely downwards and backwards from the back to the abdomen. The Dorsal and Anal fins are blue in colour, fringed with a narrow line of red.

Depôt Pond.

In June 1896, the blood of fifteen specimens was examined. One† presented over 200,000 of the small variety of hæmatozoa in each c.cm. of blood examined. In three fish the hæmatozoa were swarming (over 50 in a field of the microscope), in one numerous (20), in nine few (5), and in one specimen no parasites were found.

Old Jumna River.

The hæmatozoa were found to be swarming in one specimen, few in a second, and absent from the blood of seven.

Grisauli or *Girai* (*Punj*), *Murral* (*Hindustani*).—These fish belong to the order *Acanthopterygii*; family *Ophiscephilidæ*; genus *Ophiscephalus*; species *O. Striatus*.

*TABLE LXXI.

Giving the measurements of thirteen specimens of Trichogaster *for diagnostic purposes.*

Serial No.	No. of coloured bands on body.	Length over all.	Length of head.	Length of body.	Length of tail.	Vertical height of body.	Length of Pectoral fin.	Pectoral fin, Number of spines.	Number of spines, Dorsal Fin.		Number of spines, Anal Fin.		Caudal Fin, Number of spines.	Length of Pectoral Appendages.	Remarks.
									Anterior portion.	Posterior portion.	Anterior portion.	Posterior portion.			
		Inches.	Inches.	Inches.	Inches.	Inches.	Inches.							Inches.	
1	11	3 1/2	1/4	1 1/4	1/4	1 1/16	3/4	10	16	10	17	13	17	2 1/8	Bands varied from 8 to 13 in number, total length 1 13/16 to 3 1/2 inches, length of Pectoral fin from 1/2 to 11/16 of inch, Caudal fin 1/4 to 5/8 inch, D. 16—17/10—13, P. 8.—10, C. 15—18, A. 16—17/8—11
2	12	3 1/4	3/4	1 1/2	3/4	1	11/16	10	16	9	16	15	18	2 1/8	
3	9	3 1/16	3/4	1 5/8	11/16	1 1/16	3/4	10	16	10	17	14	17	2	
4	11	3 5/16	13/16	1 13/16	11/16	1 1/8	3/4	10	16	11	16	15	17	2	
5	12	3 3/8	13/16	1 13/16	3/4	1 1/8	3/4	9	16	10	16	14	16	1 5/8	
6	10	3 5/16	13/16	1 11/16	11/16	1 1/16	3/4	8	17	10	16	15	16	2 1/8	
7	10	3 1/2	13/16	1 13/16	1/8	1 1/8	3/4	9	16	11	16	15	15	2 1/8	
8	11	3 7/16	13/16	1 13/16	13/16	1 1/16	3/4	9	17	10	17	16	15	2 1/16	
9	10	3 1/8	11/16	1 13/16	5/8	1 1/8	11/16	9	17	8	17	15	15	2	
10	8	3 3/16	11/16	1 11/16	13/16	1 1/16	11/16	9	16	9	17	14	15	1 15/16	
11	8	3	11/16	1 5/8	11/16	1 1/16	11/16	9	17	10	17	10	15	1 11/16	
12	13	2	1/2	1 1/16	7/16	1 1/16	3/8	8	16	8	16	15	15	1 3/16	
13	13	1 7/8	1/4	15/16	1/16	3/4	3/8	8	16	10	17	15	15	1 1/4	

† Negative results followed the inoculation of small animals inoculated with this hæmatozoon.

Depôt Pond. A large variety of hæmatozoon was present in the blood of six specimens of this species of fish examined.

Old Jumna River. The large variety of hæmatozoon was found in the blood of three fish examined.

Singhi or Tinghi.—This fish belongs to the order *Physostonii*; family *Siluridæ*; genus *Macrones*; species *M. Seenghala* and *M. Tengara*.

These fish were caught only in the Old Jumna River, but were not seen in the West Jumna Canal or in the neighbouring ponds. The small variety of the hæmatozoon were found in the blood of all the specimens examined; they never exceeded five in a field of the microscope, Zeiss D, ocular No. 4.

Blood from numerous other species of fish obtained from a similar source to the above mentioned, was submitted to microscopical examination, but no hæmatozoa were found in any of the specimens. The names of the fish were as follows:—

Pattia (Hindu.), *Barbus stigma*.
Mohaylee (Hindu.), *Labeo diplostomus*.
Purri (Punjab), *Notopterus kapirat*.
Kugga (Punjab), *Clarias magur*.
Rewah or Rohwa (Hindu.), *Cirrhnia reba*.

Water.—Samples for microscopical examination were obtained from the river and from stagnant pools in the neighbourhood. Kathgodam.

Flies, Mosquitoes and Ticks.—Were collected from the bodies of the Tonga, Ekka ponies, and from dogs. Different species of *diptera* were also caught in the vicinity of stagnant water.

In no instance, however, was the *Trypanosoma* found.

Filariasis.

Two horses employed in the Dâk Gharies at Mohand were found to have filaria in every specimen of their blood examined. Mohand, N.-W. P.

I was shown in the Government Depôt one horse, the subject of slight paraplegia, and at a later date a second animal was observed to be suffering from similar symptoms. An acute case of the same disease occurred on the 11th June, death taking place on the 17th instant. The chief points of interest in the last case being— Karnal.

(*i*) The suddenness with which the symptoms supervened.
(*ii*) The presence of the Embryo filaria papillosa in the circulation.
(*iii*) The administration of Arsenic in increasing doses (5); disappearance of the filaria from the blood after 18 grains had been given.
(*iv*) High temperature, 108°F., at death, which rose to 111·2°*F.* seventeen minutes later.
(*v*) The venous engorgement of the vessels on the superior surface of the spinal cord, below the 16th Dorsal vertebra, and the presence of a clot due to extravasation of blood on a level with the 17th Dorsal vertebra. These changes were most probably due to the impaction of a mature filaria in one of the vessels of the cord, and by its prolonged efforts to become free, caused rupture of the walls of the blood vessel and consequent hæmorrhage. The presence of the clot together with the inflammation set up would fully account for the marked paralysis from which the animal suffered.

Two bullocks out of thirty examined were found on microscopical examination of their blood to have numerous Embryo-filaria present in every specimen examined:—

(*i*) Bullock K_{211}-89-C.H. was isolated in paddock No. I on account of mange, but has now recovered. This animal was in poor condition:—

June	13th	1896.	Several specimens of blood examined; mean number of filariæ							31
„	14th	„	„	„	„	„	„	„	„	17
„	15th	„	„	„	„	„	„	„	„	15
„	16th	„	„	„	„	„	„	„	„	15

(*ii*) Bullock 20 93, was an inmate of the Bovine Hospital suffering from Eczema. June 13th 1896, mean of three blood specimens examinedgave 20 Embryo filariæ.

The bullock, the subject of Surra and Filariasis in December 1895, is now convalescent and in good condition. The blood examined microscopically on several occasions (June 1896) always presented a normal appearance.

Summary of Results of investigations made during the Hot season.

1. Of the number of animals, horses, mules, bovines, whose blood was submitted to microscopical examination (many of them on several occasions) during my visits to various known centres of Surra, not one animal was found to be suffering from that disease. Surra Trypanosoma.

2. Negative results with regard to the *Trypanosoma* followed the large number of observations of blood and body fluids derived from different species of Flies and Ticks.

3. Negative results followed the microscopical examination of the various samples of running and stagnant water, derived from every available source at the localities visited.

4. During the microscopical examination of the blood of the various species of fish, the 'Chachari' obtained from stagnant water, on Remount Depot Estate, supplied the most unexpected results, the circulation of one specimen literally teeming with a small variety of hæmatozoa, while in several other specimens the organisms were noted as swarming.

Filariasis. 5. Two horses posted in stables at the Mohand Pass were discovered to be the subjects of the Filaria papillosa.

Three horses at Karnal exhibited symptoms of partial paralysis in one of which, an acute case, the paralysis became complete and death followed with hyperpyrexia. In the circulation of this animal numerous Embryo filaria were observed microscopically.

Two bullocks out of thirty examined exhibited the Filaria in their circulation, 126 worms being found in four specimens of blood derived from one and 60 in the other, or a ratio per specimen of 31·5 and 15, respectively.

The complete recovery of Bullock which was the subject of Surra, Filariasis, and Intermittent fever in December 1895.

2. Rainy Season Tour.

On September 7th, 1896, I arrived at Saharanpur and proceeded to the Mohand Pass, where in 1894 over 80 horses succumbed to Surra. The blood of some 135 horses in all, stationed at Mohand, Tunbara, Landibara and Asarori was subjected to microscopical examination, but only two animals were found to be the subjects of Surra and these at the latter station.* The infected animals, brought from the North Punjab, were the property of the European Firm of Dak proprietors, who have for several years past taken the precaution to boil the water before giving it to their animals in this locality. The fodder issued by this firm is dry grass, collected during the cold season, November to January, from high ground; the corn in the form of oats is likewise cleaned and screened.

The stables at Asarori are situated on the banks of a river, at an elevation of 3,000 feet, about half a mile from the crest of the north-eastern slope of the outer range of the Siwaliks. Although little or no rain in comparison with other seasons has fallen between Saharanpur and Landibara, the last chowki near the summit of the outer Siwaliks range, nevertheless the normal quantity has fallen this season between Asarori and Rajpur to the north-east. The stables at Asarori, where the majority of the animals belonging to the native owners are quartered, are nearly on a level with the bed of the river and the ground is swampy. On the other hand the European firm have constructed their buildings on the highest available site above the road, and introduced the above mentioned precautionary measures; nevertheless the only equines affected with Surra on the 49 miles of road between Saharanpur and Rajpur up to September 9th were two of the eight horses stationed at Asarori, 3,000 feet elevation, which were thought to be protected from the insanitary surroundings.

At Saharanpur similar investigations to those previously recorded during my hot season tour were made, but the results proved negative.

Karnal. The microscopical observations regarding water, blood of fish, flies and ticks made during my tour in the hot season were repeated in detail during this visit.

Water.—Numerous infusoria were found in the different samples submitted to examination but no *Trypanosoma* was observed.

Fish.—Cacheri (*Trichogaster fasciatus*, or a variety of this species). In the blood of eleven specimens examined the small variety of the hæmatozoon was found present varying from numerous to few; and absent from the circulation of seven.

Depôt Pond.

Old Jumna River. The small variety of hæmatozoon was present in one and absent from the blood of two fish examined.

Old Jumna River. *Grisauli or Girai* (*Ophiocephalus Striatus*).—No hæmatozoa were found in the blood of the three specimens examined.

Singhi (*Macrones seenghala.*)—The blood of three specimens of this species was submitted to examination with the result that the large variety of hæmatozoon was found to be numerous in one and absent from two fish.

Jumna River.

Specimens of blood were likewise taken from fish of different genera, as was the case during the investigations conducted during the hot season, but the results proved again to be of a negative character.

Flies.—The body fluids of numerous flies, embracing a variety of genera and species caught on the bodies of animals, and in the vicinity of swamps and stagnant water, were submitted to microscopical examination, but with negative results.

Ticks.—Specimens of Ixodes were taken from horses and dogs. Usually the horses in this district suffer much from these acariases, but only two specimens were found on 153 horses examined for them.

---

* After my visit to this Station (Asarori), four additional horses succumbed to Surra belonging Messrs. Smith and Rodwell. The disease next visited Landibara and four animals died the property of Native owners. Both these chowkis are by thick Jungle and situated close to the river.

The blood of one hundred and thirty-five equines was submitted to microscopical examination at the four stations of the Pass, with the following results :— Mohand Pass.

Of thirty-four animals stationed at Mohand, no case of Surra was discovered.

Of thirty-five animals at Tunbara, no case of Surra was found.

Of eighteen animals at Landibara, no case of Surra was found.

At Asarori, out of thirty-four animals stationed there, two horses were found to be suffering from Surra.

The remaining fourteen animals examined were either ekka ponies or animals locally owned; in all the Surra hæmatozoon was absent.

Water.—The rainfall during this season has been fitful, but has not lasted any time although falling heavily for several hours on each occasion.

Samples of water were obtained for examination between Saharanpur and the Mohand Pass, from swamps, ponds and ditches.

Samples of water were also obtained for examination from Mohand, Tunbara, Landibara.

Four samples from the river and ponds at Asarori.

Flies.—Hundreds of flies belonging to some ten different species, together with ticks from equines and canines were collected and their body fluids submitted to microscopical examination.

Fish.—The blood of small fish obtained from the Mohand Rao was also submitted to microscopical examination.

Owing to the presence of a severe outbreak of Surra, amongst the dâk ponies stationed between Kathgodam and the Naini Tal Brewery, which first showed itself in July 1896, it was no use wasting time in the microscopical examination of the water, etc. Kathgodam.

At every station up the road where the animals were standing one had only to observe the flies on the diseased horses to see that their body cavities were distended with blood, and they passed freely from one animal to another. On microscopical examination of the blood of eleven tonga ponies at Amparao stable, the Surra hæmatazoon was found to be swarming in ten, and absent owing to a period of intermission, in the eleventh.

Filariasis.—The blood of one hundred and thirty-five equines was submitted to microscopical examination at the four stations of the Pass, with the following results :— Mohand Pass.

Of thirty-four stationed at Mohand two animals presented Embryo-filaria in their blood.

Of thirty-five animals at Tunbara the blood of five contained the filaria. One animal with two bursati sores on the hind fetlocks presented an average of forty-eight filariæ in each cover-glass of blood examined. A second animal presented ten in each specimen.

Of eighteen animals at Landibara the blood of all was free from the filaria.

At Asarori, out of thirty-four animals stationed there, three presented the Embryo-filaria in their blood in small numbers.

On microscopical examination of the blood of thirty-six Government Siege Train Bullocks only one presented the Embryo-filaria. Karnal.

No cases of "filaria oculi" in horses have occurred since the supply of water from the swamps in Nos. II and V have been shut off or filled in, as recommended in January 1896. In the four years previous to this, 1892 to 1895 inclusive, thirty-nine cases of filaria oculi and fifty-one of paralysis occurred, of which four and thirty-four respectively died or were destroyed.

Classification of certain species of flies caught upon the bodies of animals, the subjects of Surra.

All species of flies may become dangerous by transferring disease germs, which adhere to their mouths and limbs, from one animal to another, as when alighting and feeding upon the blood of a Surra patient, they transfer their attentions to equines with some exposed wound or slight solution of continuity of the skin. In such a case it is almost inevitable that the healthy animal will contract Surra. The species of *Diptera* which are essentially dangerous on account of their formidable bite are provided with pointed instruments as sharp as needles, with which they pierce the cuticle and draw blood with the greatest ease. These species of flies are able to obtain for themselves, in the absence of sores on the bodies of the affected animals, the soiled material with which they may inoculate the healthy animals they bite. The flies which infest equines the most during different seasons of the year in this country appear to be as follows—All through the year the *Hippoboscidæ*, two varieties (*i*) which principally attacks bovines and equines, (*ii*) a smaller variety, which infests dogs. In the plains at the beginning of the rains the Mhet (Burmese), a species of *Tabanus*, was always observed, as also in Poona and the Mohand Pass (North-Western Provinces).

In the hot season, especially towards the end of May and the beginning of June before the rains set in, the large green-eyed fly, the *Tabanus lineola* or an allied species, is present in great force. Sometimes it re-appears during a spell of fine weather during the monsoon season, in September or beginning of October, but directly the cold weather sets in these flies may be found dead by hundreds.

Several fairly large varieties of the *Muscidæ* have been caught on diseased animals, with their body cavities distended with blood, which, when submitted to microscopical examination, have been found to contain innumerable *Trypanosoma*. These flies up to the present have not been identified and placed in their respective species.

At Poona the Surra animals, especially mules, and at the Surra camp at Karnal the horses were annoyed night and day by mosquitoes (*Culicidæ*), which were only kept in abeyance by making fires to windward of the animals and allowing the smoke to envelope them.

The following notes with regard to the above mentioned families of *Diptera* have been principally abstracted from the works of the Chief British and American authorities on this branch of science.

The body fluids of flies obtained from every available source were submitted to microscopical examination. During a sojourn in a locality we engaged coolies to supplement our own staff; consequently fresh supplies of *Diptera* were brought in several times daily. These were carefully examined in the fresh state. In different districts one or other species of flies generally predominates, but they vary also in number and kind according to the season of the year.

In the plains the commonest variety is the "louse fly" which infest horses, cattle, sheep and other animals, especially dogs. They belong to the family *Hippoboscidæ*, "head prone; neck lying on the prosternum", which is again sub-divided into six genera of which *Hippobosca* the first is frequently separated as a sub-order under the term Pupi-para, on account of the curious method of reproduction.

Walker includes *Hippoboscidæ* under the *Eproboscidæ*. Loew and Sacken objected to uniting under the head of *Brachycera*, all those families which cannot be referred to the *Nemocera*, especially to the union of the *Hipposcidæ* with the other *Brachycera*, since both the history of their development and their internal and external anatomy essentially differ from them. These authorities include them under a third section, *Coriacea*, co-ordinate to the *Nemocera* and *Brachycera* and having the same systematic value.

"The species of this family pass their egg-like and larva state in the body of the mother, and when born are pupæ, or larvæ just ready to assume the pupa state, as is proved by their size, which nearly equals that of the parent fly, by their slight motion when first extruded, by spiraculiform points which run down each side of them, and by their changing into perfect flies. Each female produces a single egg. The proboscis consists of a pair of hairy coriaceous valves, which include a very slender rigid tube or siphuncle, the instrument of suction, which is found by the union of two setiform pieces."—(F. Walker.)

According to Dufour and Leuckart quoted by Packard,* the females of this species have an irregular uterus-like enlargement of the oviduct, which furnishes a milk-like secretion for the nourishment of the larvæ.

"The flies are parasites living largely upon birds but sometimes upon animals. The whole body is depressed or flattened, and birds of prey are most usually affected. It is rare to find a hawk, eagle or owl upon which several specimens of these peculiar flies cannot be found. They move rapidly, and their first impulse is always to seek shelter when driven from their original host. A few species are wingless, and among them is the so-called "sheep tick" *Melophagus ovinus*, which is usually looked upon as a louse, and resembles one in the prominent proboscis, the lack of wings, and the strongly developed legs, on which the claws are very prominent."—(Smith.)

The Forest-fly or Horse-tick (*Hippobosa equina*) is very abundant in the New Forest, Hampshire. The description given of it by Walker is as follows:—"Nigra, capite thoraceque fulvo flavoque varis, alis sordide hyalinis, pedibus fulvis, tibiis posterioribus et femoribus nigro-subfasciatis, unguibus nigris. Long. 3—3½; alar. 8 lin." According to A. E. Omerod the Forest-fly must be taken as a type of the division. It causes irritation both by blood-sucking and by creeping, which it can do backwards, forwards, or sideways with great nimbleness, on the parts of the animal especially preferred for infestation.

It is thought probable that the Indian cattle-fly belongs to the species *Hippobosca-maculata* (Leach).

Another set of troublesome creatures in India are the Gad-flies or Horse-flies belonging to the family *Tabanidæ*. This order, I think, includes the "Bara Dhang" (Hindustani) and Hmet (Burmese) which are probably varieties of the species *T. lineola*, the green-head fly, and *T. tropicus*.

"They have short, broad heads, enormous eyes, and short, though many jointed, feelers. The abdomen is oval, a little flattened, and the body is convex and powerful. The mouth parts are well developed, consisting of a series of five sharp-pointed lancets, so rigid that they readily pierce the skin and draw blood almost as soon as they touch. These flies appear in the summer, chiefly abound in woods or the edges of woodlands, and sometimes in low meadows or

* Francis Walker	Insecta Britannica "Diptera"	1853,	London.
A. E. Packard	Study of Insects (A guide to the)	1869,	United States, America.
J. B. Smith	Economic Entomology	1896,	Ditto.
A. E. Omerod	Agricultural Entomology	1884,	London.
H. Loew and Osten Sacken.	Monographs of the Diptera of North America	1862—1873	Smithsonian Institution, Washington.
Smithsonian Institution.	Bulletin of the United States National Museum.	1886,	Washington.

marshy places. The flight is powerful ; the males frequent flowers, the females with their sharp mouths pierce the skins and feed on the blood of quadrupeds. In England the Ox-Gad-fly, *T. bovinus*, is the most common variety, but in the United States *T. atratus* is a common species, while the *T. cinctus*, orange-belted Horse-fly, is smaller and less abundant. The *T. lineola*, as in India, is the most common American species, " thousands of them appearing in the hotter parts of the summer, when the sun is shining on the marshes and western prairies ; horses and cattle are sometimes worried to death by their harassing bites. In cloudy weather they do not fly and they perish on the cool frosty night of September." (Packard) Walsh has shown that in its larval state the Horse-fly is useful to man as it feeds on snails and probably the larvæ of other root eating insects. The larvæ of other species are aquatic, living under submerged objects.

The family *Muscidæ* is the largest in number of genera and species in the order as well as the most difficult to classify. The common 'House-fly' " the Blue bottle " and the " Flesh-fly " are examples and may be considered as typical forms, which most of the species resemble, not necessarily in colour or markings, but in general type of structure.

The Blow-fly, *Calliphora Vomitoriæ.*

The " Screw worm " fly, *Lucilia macellaria.*—A common species usually feeds upon dead or decaying animal matter. Under some circumstances, however, it attacks living animals, and occasionally becomes a pest in the South or South-West States of America.

The stable fly, *Stomoxys Calcitraus.*—This has the mouth parts formed for piercing, and annoys animals by alighting upon and sucking the blood of parts that cannot be reached by them with head or tail.

The Horn-fly, *Hæmatobia Serrata*, like the stable-fly, is a blood-sucker, and both species are often found on animals at the same time.

The Tsetse-fly, *Glossina morsitans*, is a member of this family. It is allied to Stomoxys, the species of which bite very sharply.

S. calcitrœaus has a well developed proboscis, enabling it to bite severely.

The " *Warega-fly* " of Brazil, which is said to be a " pest of both men and animals ", is a species of Musca and is said to lay its eggs in the skin ; large and painful swellings are formed.

The " *Tdia Bigoti,*" according to Coquerel and Mondiere, produces a disease in the natives of Senegal, probably by ovipositing on the skin, thus giving rise to hard red fluctuating tumours in which larva of this fly reside.

The family of mosquitoes or gnats (*culicidæ*) have the mouth parts very long and slender ; the mascillæ and mandibles are free and lancet-like. The females alone bite, for in the males the piercing mouth structures are not well developed, and they are, therefore, not capable of sucking blood, but spend their lives in the retirement of the swamps and jungle.

" This genus is too well-known, from the blood-sucking propensity of the female, to require any particular notice. It is plentiful in all countries, whether arctic or tropical, which abound in wood and water. The female lays about 300 eggs ; nearly a month intervenes between the egg-state and the fly-state, and there are several successive generations in one year. Gnats emit no sound when flying early, before their thirst for blood is awakened. The warmer the weather, the greater is their thirst for blood, the more forcible their flight, the motion of their wings more rapid, and the sound produced by that motion more intense ".—(Walker.)

Ixodes, popularly known as Ticks and wood mites, are more or less flat when fasting globular when replete.

The Ixodes are found in every country, but there is no constant correspondence between the species of host and that of the parasite ; the specific determination of the different forms is rendered difficult by the great confusion that prevails. The male and females of the same species have often been mistaken for different species, and the same species has received distinct specific names because individuals belonging to it were observed on different hosts. Animals, however, as a general rule do not appear to suffer from their presence. " In Guadeloupe the Ixodes of Senegal are supposed to play an important part in the development of a serious affection known there as *Farcy* and which is witnessed in horses, cattle and mules ; the ulcerous wounds just referred to are the starting-point of the disease. Nocard has recently demonstrated that this farcy of the ox is a malady of microbic origin ; and it can be conceived that the Ixodes may be the agents of inoculation of the micro-organism that determines such a disease "—(Neumann).

G. I. C. P. O.—No 60 I. G., C. V. D.—23-12-97.—300.—G. R

4/8631
3

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1898-99.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1899.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1898-99.

General Remarks.

1. *Officers in charge of the Laboratory during the year.*—Dr. Lingard was in charge of the Laboratory from the beginning of the year under review (1st April) up to the 7th October, when he unfortunately fell ill and went into the Ramsay Hospital at Naini Tal, and was sent on one year's sick leave dating from October the 7th. Veterinary-Lieutenant G. K. Walker, of the Civil Veterinary Department, assumed charge of the Laboratory on October 10th, and on November the 15th Captain Leonard Rogers, of the Indian Medical Service, was appointed to officiate as Imperial Bacteriologist while Dr. Lingard is on sick leave or until further orders, and after meeting the Inspector General of the Civil Veterinary Department at Umballa and visiting Dr. Lingard at Naini Tal, he reached the Laboratory on November the 22nd, 1898, and remained in charge during the rest of the year.

Veterinary-Lieutenant G. K. Walker has held the post of Assistant Imperial Bacteriologist throughout the year, and I am much indebted to him for his excellent management of all the outdoor work of the Laboratory, and for much assistance in carrying out the rinderpest and other experimental work.

2. *Tours undertaken during the year.*—Dr. Lingard was on tour from May 29th to June 13th, during which time he was engaged on an investigation of equine disease in the Hathawa State, and on the Saharanpur-Dehra dâk line. From July 10th to the 19th, he was engaged on an investigation of glanders on the Saharanpur-Dehra road, and from August 28th to Septemtember 25th he was absent from the Laboratory on business with the Collector of Bareilly and investigating cattle and equine diseases on the Saharanpur-Dehra line, and unfortunately fell ill shortly after his return from the last mentioned journey.

Dr. Lingard was too ill when I saw him to be able to talk for more than a very short time, so he was unable to give me any information with regard to the work that was being carried on at the Laboratory at the time he was suddenly taken ill; and as all the papers in connection with his work are in his possession, I am unable to give any details of the investigations that were carried out by him during the portion of the year he was in charge of the Laboratory. In answer to a letter from me on the subject, which I received some two months ago, he kindly promised to send me such details of his work as he wished to be published in the Annual Report, but this has not yet come to hand, and will be forwarded separately as soon as it is received. It was very unfortunate that I was not able to have the benefit of Dr. Lingard's most recent and unpublished experience of Surra, as I was, on this account, unable to continue his work on the subject on his own lines; but, on the other hand, this left me free to take up the important work on rinderpest, which the now nearly completed state of the Laboratory allowed of being done under advantageous circumstances, a preliminary account of which will be found in paragraphs 12 to 33 of this report.

This work has been steadily pursued, and in consequence of its requiring my constant attention, I have not been able to undertake any extensive tours to investigate the other important diseases which demand attention. I was only absent from the Laboratory for three days in December, to meet the Lieutenant-Governor of the North-Western Provinces with regard to the scheme for the establishment of the experimental depôt at Bareilly; for five days in January to meet the Plague Commissioners at Agra with reference to their application for me to be allowed to visit on their behalf any outbreaks of Sunjar or Mahamari in Kumaon Hills which might be reported; and for five days in February visiting an outbreak of so-called Sunjar some 60 miles from the Laboratory by road, which I was able to identify with relapsing or Famine fever, and to find the spirillum of this disease in the blood of a case. A report on this subject will be supplied to the Plague Commissioners.

During the interval between the departure of Dr. Lingard from the Laboratory and the arrival of his successor, the Assistant Bacteriologist carried on the duties, and took advantage of this interval to have the Laboratory thoroughly cleaned and whitewashed, which apparently had not been done since it was built four years ago. He also isolated an organism from the blood of a horse which had died at Rawalpindi and which had been sent for examination to the Laboratory, but it proved not to be pathogenic when tested on Laboratory animals. Work on Surra was also continued.

December was occupied in completing the cleaning of the Laboratory and in going through all the stores, etc., to see what would be required to be ordered for the rinderpest work, and in setting up and getting into working order a quantity of new apparatus which had just been received from Europe.

Much time had also to be spent in reading up all the recent literature on the subjects which were being taken up this year.

3. *Journal of the Journeys undertaken during 1898-99.*—The following is a complete list of the tours of the year under review, which have been referred to in the preceeding paragraph :—

1898.

Investigation of equine disease :—

May 21 to 25	. Muktesar to Savan and Hathuwa.
„ 26 to 28	. Halt at Hathuwa.
„ 29	. Hathuwa to Pertabpur.
„ 30	. Halt.
„ 31	. Pertabpur to Hathuwa.
June 1 to 5	. Hathuwa to Saharanpur, Mohand, Bindal, etc.
„ 6 to 7	. Halt at Saharanpur.
„ 8 to 13	. Saharanpur to Muktesar.

Investigation of glanders at Saharanpur-Rajpur Road :—

July 10 to 13	. Muktesar to Saharanpur and Mohand.
„ 14	. Mohand to Rajpur and back.
„ 15	. Halt at Mohand.
„ 16 to 17	. Mohand to Bareilly.
„ 18	. Halt at Bareilly.
„ 19 to 21	. Bareilly to Muktesar.

To settle land business with Collector of Bareilly, and investigation of equine and cattle diseases :—

August 28 to 29	. Muktesar to Bareilly.
„ 30	. Halt at Bareilly.
„ 31 to Sep. 8	. Bareilly to Simla (on casual leave, as per R. and A. telegrams).
September 9	. Saharanpur to Mohand.
„ 10 to 11	. Halt at Mohand.
„ 12 to 13	. Mohand to Saharanpur and Bareilly.
„ 14	. Halt at Bareilly.
„ 15 to 16	. Bareilly to Naini Tal and back to Kathgodam.
„ 17 to 18	. Kathgodam to Saharanpur.
„ 19 to 21	. Halt at Saharanpur.
„ 22 to 25	. Saharanpur to Muktesar.

To join new appointment :—

November	15	. Lucknow to Meerut.
„	16 to 17	. Halt at Meerut.
„	18	. Meerut to Umballa.
„	19	. Umballa to Bareilly.
„	20	. Bareilly to Naini Tal.
„	21	. Halt at Naini Tal.
„	22	. Naini Tal to Muktesar.

Interview with His Honour the Lieutenant-Governor of the North Western Provinces regarding land at Bareilly:—

December	3 to 4	. Muktesar to Bareilly.
„	5	. Halt at Bareilly.
„	6 to 7	. Bareilly to Muktesar.

1899.

Rinderpest investigation :—

January	3	. Muktesar to Ranibag.
„	4	. Ranibag to Muktesar.

To join Plague Commission at Agra :—

January	8 to 9	. Muktesar to Agra.
„	10 to 11	. Halt at Agra.
„	12 to 14	. Agra to Muktesar.

Sanjar investigation :—

February	18 to 19	. Muktesar to Champhawat.
„	20	. Champhawat to Sunival village and back.
„	21 to 22	. Champhawat to Muktesar.

To examine records of outbreaks of Sanjar and Mahamari in the Deputy Commissioner's Office :—

March	10	. Muktesar to Almora.
„	11	. Halt at Almora.
„	12	. Almora to Muktesar.

During the official year 1898-99, the journeys up to the end of September 1898 were performed by Dr. A. Lingard, and since the middle of November 1898, by the Officiating Imperial Bacteriologist.

4. *The Laboratory Buildings.*—During the year much has been done towards the completion of the out-buildings of the Laboratory. The whole of the cattle-sheds have been finished, and have been in full use during the last four months. The sterilising house was finished and fitted up in December, and at about the same time the small animals' house, the *store-house* and snow-well were also completed. The *postmortem* room and incinerator were finished at an earlier date, and the cold room was ready early in April. Gas has been made regularly for the past five months. The hydrants of the fire protective scheme have been fitted and the tanks are now being constructed, as are also the stables. The new water-supply scheme, which is badly required, has now been sanctioned, and will, it is hoped, be shortly carried out. Kennels are being estimated for. The residence of the Head Laboratory Assistant has also been finished within the past year. Lieutenant Crookshank, R.E., has been District Engineer throughout the year, and much credit is due to him for the great progress which has been made with the new works.

Future requirements.—At the present time the Laboratory is in full working order and all the most essential requirements have been supplied. What is now wanted is to develop the work of the institution, and for this purpose the most urgent requirement is additional accommodation for any officers who may be able to visit the Laboratory for the purpose of carrying on special investigations or to study the latest advances or any important work which is being carried on at Muktesar. Quarters for the two Veterinary Assistants are also required, especially as in addition to the two who are stationed here others will probably be sent to the Laboratory in the near future to study the preventive treatment of Rinderpest preparatory to carrying out the methods in outbreaks of the disease. The quarters of the artist and Laboratory assistant require to be reroofed and repaired, and the Ritani water-supply needs to be piped, as the present open channel is very unsatisfactory. Preliminary estimates for these improvements are being asked for.

5. *Experimental Station at Bareilly*—A small depôt, as an off-shoot of the Laboratory to be placed at Bareilly, has been sanctioned in order to allow

of any important experiments being repeated, when necessary, in the plains under different conditions to those which obtain at Muktesar and for other purposes, and it is hoped that necessary money will be allotted in time for the buildings to be completed before the cold weather, as the land has already been taken over, with the sanction of His Honour the Lieutenant-Governor of the North-Western Provinces, who kindly granted me an interview on the subject at Bareilly in January last. The site which has been selected is situated four miles out of Bareilly on the Badaun Road, and is about twelve acres in extent. One laboratory room, with a quarter for a Veterinary Assistant and a godown, will be constructed, together with sheds, which will suffice for cattle for rinderpest experiments, if it is found necessary to repeat these on plain cattle there in the cold weather, or for horses or other animals if required. The officers of the Laboratory will either live in Bareilly or camp on the ground when working at this branch station.

6. *Minor Improvements.*—The entrance and other roads have been re-aligned and railings have been put up along them. A garden has been laid out on the ground to the north of the main building and also by the side of the space leading to the Laboratory, and an avenue of deodars has been planted by the side of the principal entrance road, and other small improvements tending towards tidiness and good appearance of the place have been carried out during the last few months.

7. *Apparatus purchased during the Year.*—Some important additions have been made during the past year to the apparatus of the Laboratory. Two new incubators for the maufacture of blood serum for a culture medium have been obtained, and an instrument for evaporating serums and other material at a low temperature in a vacuum has been received. A centrifugal machine worked by a gas engine has been ordered, and as by means of this apparatus twice as much serum can be obtained from a given quantity of blood as can be got by letting it clot and separate in the way which has to be used at present, the output of rinderpest serum will be greatly increased when this machine is received and got into working order. The chemical room has still to be fitted up with many reagents, but money will be available for this and other necessaries during the current year. Some things which were required for the rinderpest work have also been purchased out of this year's grant.

8. *The Library.*—Some new reference works have been added to the library during the past year in addition to the periodicals received. The latter have not, however, been bound since they were first paid for out of a Government grant, that is, for the last four years, and the small sum of R50 which is allowed yearly for this purpose under the head of "Contingencies" is totally inadequate for the purpose. As, however, the question of the purchase by the Government of Dr. Lingard's very valuable and essential library of reference works and important pathological and bacteriological journals, which include the earlier numbers of nearly most of those which are now purchased yearly with the Government grant and extend for several years back, may shortly come up, the question of the binding of the library journals will be left for the present, so that, if Dr. Lingard's volumes are purchased, the latter ones may be bound in something like the same style.

9. *Cultivation.*—In order to overcome the difficulty of obtaining fodder for the cattle at Muktesar, at the suggestion of the Inspector General of the Civil Veterinary Department, some of the land belonging to the Laboratory was placed under cultivation. This could only be done to a very limited extent on account of want of labour, but as no Rinderpest experiments were going on during the latter part of 1898, some of the coolies who had been sanctioned as cattle attendants were available for employment on cultivation. During the present year the labour difficulty has been greater owing to the cattle attendants being fully employed in the sheds, and permission has been asked to spend a portion of the sum allotted under the head of "Feed and keep of cattle" on the employment of coolies for cultivation, as this will result in some saving. In spite of these disadvantages, some progress has been made with the cultivation. Some Jowar seed was ordered in April 1898, but as it was not received until July, it did not have a fair chance and was a failure at Muktesar, but did somewhat better at Ritani, which is several hundred feet lower down. In September, hill barley was sown both at Muktesar and at Ritani, and good crops have resulted, although some damage was done by hail-storms in April. During the

last winter more land was cleared at Ritani, and 39 maunds of Jowar seed from Babugarh has been obtained and put in partly at Ritani and partly at Muktesar, and is coming up well. The ploughing is done by the experimental cattle, while the Jamadar supervises all the cultivation under the guidance of the Assistant Bacteriologist, to whom great credit is due for his work in developing the cultivation. A small quantity of several hill crops are being tried as an experiment on some of the Laboratory land, so that any which are successful and suitable for fodder in place of grass, which is only obtainable with great difficulty, will be planted more extensively next year.

10. *Reservation of the Muktesar Forest.*—Dr. Lingard having applied for the reservation of the forest which covers almost all the land taken up for the Laboratory, the Forest Settlement Officer visited Muktesar in February to meet the villagers who might be affected by such a measure. I went round the whole of the boundary with him in the course of three days, and agreed to the neighbouring villagers being permitted to retain rights of grassing for their cattle and for dead wood on certain of the outlying portions of the property, which the Settlement Officer considered should in fairness be allowed them, leaving the whole of the more central portion of the forest to be reserved, and orders were passed on these lines. As the necessary three months, during which appeals from the decision given may be lodged, have now passed without my receiving notice of any being sent in, I presume that this arrangement, which is both advantageous to the Laboratory and fair to the villages, has been confirmed, and the forest authorities are being communicated with on the subject of the necessary forest-guards. This measure, which will prevent the cattle of the villages coming on to the central portions of the Laboratory land, is all the more necessary now that rinderpest work is being carried on in order to prevent the disease being carried to the neighbouring parts, and the settlement of the question is very satisfactory.

11. *Work now carried on in the Laboratory.*—During the last four months the preparation of certain bacterial products, which are of therapeutic value in veterinary practice, has been undertaken.

Mallein has been made and is now being tested, and it is hoped that several thousand doses will be available within a short time, and as large a quantity as is found by experience to be necessary will in future be prepared and kept in stock at the Laboratory.

Tuberculin is also being made, and it is hoped that arrangements may be made for the cattle of dairies and other places being tested with this material, as the amount of tubercular disease in Indian cattle does not appear to be very accurately known, although tubercular disease among human beings is only too common in this country, part of which may possibly be caused through infection from the milk of tuberculous cattle. It is worthy of note, in this connection, that it was not until the use of tuberculin on a large scale was introduced into England and other countries that the extreme prevalence of this disease among cows was discovered, while it is only by the free use of this reagent that herds can be freed from the disease and the absolute safety of the milk in this respect ensured.

The investigation of Surra has been continued as far as time would permit; and as from recent work of the Tsetse-fly Committee of the Royal Society, which has just been published, it appears more than ever probably that this latter disease and Surra are identical, some of the work on Tsetse-fly disease which has been carried out by that Committee is now being tested in the case of Surra, in order to obtain further evidence as to the identity or otherwise of the two diseases; for it is evident that if they can be proved to be one and the same disease, all the work that has been done on the one affection will be applicable to the other, and the increased knowledge may possibly lead to important methods of prevention, if not of cure.

As the important rinderpest experiments that are briefly summarised in paragraphs 12 to 33 of this report demanded undivided attention and the almost constant presence of the Imperial Bacteriologist at the Laboratory, the question of Ludhiana disease could not be taken up, but it is hoped that the former work may be sufficiently advanced to allow of this being undertaken during the next cold weather.

A brief visit was paid to Roorkee and arrangements have been made for material being sent to the Laboratory for examination in the event of any cases of "Roorkee disease" occurring, while if the disease becomes at all prevalent the

station will be visited in order to allow of investigations being carried on there. Unfortunately the disease usually runs a course of but a few hours, so that it is impossible to get from the Laboratory to Roorkee after a case has been reported in time to see it; but if in the course of the cold weather work is being carried on at the Bareilly branch, it may then be possible to do so.

As it has been reported from South Africa that a fungus has been found which will readily kill off swarms of locusts, steps have been taken to obtain some of the material for the Laboratory, and it is hoped that it will shortly be received and kept growing here ready to be sent out if required. Although this pest is not so severe in India as in Africa, yet it at times causes great havoc, and the method appears to be worthy of a trial.*

The preparation of tetanus anti-toxine has also been commenced, two horses having been obtained for the purpose and the injections have been begun. The process, however, takes several months to carry through, but the recent discovery of its much more powerful curative value when it is injected directly into the brain, over the previous method of its sub-cutaneous administration, greatly enhances the value of the material, and it is hoped that it will be ready for issue in a few months' time.

The testing of the spinal cords of dogs which are thought to have died of hydrophobia and which may be forwarded to the Laboratory for that purpose is being arranged for.

Preliminary Note on Rinderpest Experiments.

12. *Brief resumé of recent work on the Subject.*—During the last three years a large amount of research work, with a view to discovering methods of protective inoculation against rinderpest, has been carried out in South Africa, with the result that several methods, differing more or less completely from each other, have been discovered and put into practice in that country. Differences of opinion as to the value of these divers methods were inevitable, and as, moreover, the conditions with regard to the prevalence and severity of the disease in India are very different from those of South Africa, it has been deemed necessary to test these methods carefully at the Muktesar Laboratory and to apply the results obtained in actual outbreaks before reporting with regard to what steps should be adopted to check the enormous loss of cattle from this disease which annually occurs in India. At the same time some new lines of inquiry have been opened out, although any great advance on the discoveries recently made in South Africa as a result of several years' work by numerous observers can hardly be expected. As it was not until January 1899, or four months ago, that these experiments were commenced, no definite conclusions have as yet been arrived at, so only a brief outline of the work that has so far been carried out can be given in this report, reserving for a future occasion a full examination of the question.

In order to make the line of inquiry as clear as possible, it will be necessary to briefly refer to the previous South African work, and to give the results obtained there. It will be remembered that Professor Koch visited South Africa in 1897 to investigate rinderpest, and in March of that year reported his discovery of the bile method of inoculation against the disease, which was very largely adopted and which he demonstrated at the Muktesar Laboratory in June of the same year. These Indian experiments, however, were not of a conclusive nature owing to the virus becoming so attenuated with after a few passages through the cattle used, as to fail to reproduce the disease. Two other attempts were subsequently made by Dr. Lingard to continue the experiments in July 1897 and in October of the same year, but with the same result, plain cattle having been used. In the meanwhile the work which was being continued in South Africa resulted in the discovery of other methods of protective inoculation which have superseded the original method of Professor Koch, an examination of which has been included in the plan of work of the experiments which are now being carried out at Muktesar. A brief description of these various methods must therefore be given, in order to allow of a clear understanding of the experiments so far carried out in this Laboratory.

13. *Koch's bile method.*—The original method of Professor Koch, the idea of which was obtained from the natives of South Africa, consisted in the subcutaneous injection of 10 cubic centimetres of sweet green bile obtained from an animal which was suffering from rinderpest and was between the sixth

*NOTE.—This fungus has now been received and will be sent out on receipt of telegraphic information of the presence of locusts in any district.

and eighth days of the disease. A local swelling forms at the seat of the inoculation, which is slowly absorbed, and ten days after the injection the animal is found to be immune to the disease. The duration of this immunity is very variable, being occasionally only of some three weeks' duration, and its average, as a result of many thousand inoculations in South Africa, has been found to be about four months. As, moreover, it was found impossible after the bile method to use other methods of producing a permanent immunity in the same animal, the method has been abandoned in South Africa in favour of others which produce a much longer or a permanent immunity. The bile was also found in the experience of most authors to actually originate the disease in some instances.

14. *The Glycerineated bile method of Dr. Edington.*—To overcome the above mentioned objections, Dr. Edington, of the Grahamstown Bacteriological Institute, introduced a method in which bile from animals which had died of rinderpest, but which was not putrid or thin and light yellow, was mixed with half its bulk of glycerine, and after being kept for eight days was injected subcutaneously, and followed after ten days with a very small quantity of virulent blood, by which means a mild attack of the disease was produced which would ensure a permanent immunity from the disease. Over three hundred thousand animals have been treated by this method with a loss of only 8 per cent. A slightly larger quantity of bile is required for this method than in Koch's, but on the other hand there is no necessity to kill the animals on the sixth to eighth day in order to get the bile, and it is claimed that a larger proportion of biles are available for use by this method, while it will not originate the disease in a healthy herd, although it should be mentioned that the advocates of the Koch's bile method claim that pure biles also never produce the affection.

15. *Defibrinated Blood of salted animals.*—This method, which was carried out on a large scale in the Transvaal by Messrs. Danysz and Bordet, consists in the inoculation of a large quantity of defibrinated blood obtained from an animal which had passed through an attack of rinderpest, and into which in some cases doses of virulent blood had been injected in order to increase the active immunity of the animals. The inoculated animal was then exposed to natural infection, by which means, being partially protected by the injection, they contracted a mild form of the disease, and were rendered permanently immune to it. This method was a great advance on the previous ones, and forms the basis of the improved serum method to be mentioned immediately, but it had the disadvantage of requiring large injections, and of there being a risk of malarial fever or red-water fever being conveyed to the inoculated animal, but fortunately the latter objection does not apply to this country, as far as we know.

16. *Simultaneous Serum method of Turner and Kolle.*—This method, which has been very widely adopted in South Africa with most encouraging success, is an improvement on the last mentioned one. It consists in injecting a small dose of a powerfully protective serum (obtained by repeated injections of gradually increased doses of virulent blood into a salted animal, and the separation of the serum from its blood), and at the same time a small dose of virulent blood into a different part of the animal's body. A mild form of the disease is produced in 90 per cent. of the animals, with a loss of only one-half per cent., and with the production of a permanent immunity, while the other 10 per cent., are also protected for some months even though they fail to react. The latest report on this method states that in Rhodesia over 100,000 animals had been inoculated with a loss of less than 1 per cent., and over 90 per cent. of them were permanently protected, with the result that the disease had been stamped out of this large tract of country.

17. *The conditions of rinderpest in India in relation to the question of protective inoculation.*—It might be thought at first sight from the above description that it only remains to put into practice in India the methods which have been so successfully used in South Africa, but a moment's consideration of the great differences between the intensity and distribution of the disease in the two countries will suffice to show that the problem is not quite so simple. In the first place, it must be remembered that in South Africa the disease found itself in a virgin soil, it never having been known there previously, and, like all epidemic diseases, it consequently spread with frightful rapidity, some twenty miles a day, and it is estimated by the best authorities that, if no

preventive measures had been discovered, 90 per cent. of the whole of the cattle of South Africa would have been carried off within a very short time,—the seriousness of which it is difficult to form any idea in a country in which both agriculture and, to a large extent, means of communication are dependent on these animals. It is obvious that under such circumstances the only measure that would stem the plague was to pass as many as possible of the animals through a mild form of the disease, so as to produce in them an immunity that would last for a life time. It was for this reason that Koch's bile method, which had been of the greatest service before more lasting ones were discovered, has now given place to the serum and glycerine bile methods.

In India, however, the conditions are totally different, for here the disease has been present for centuries, and consequently a certain degree of immunity has been gradually acquired, so that the disease is usually rather of an endemic than of an epidemic type, and is attended with a lower mortality, and has much less tendency to spread widely and rapidly than was the case in South Africa, although at times it assumes a more epidemic character as was the case in Manbhoom District in the year 1861-63, when 75,000 cattle were reported to have died of this disease, and in Assam in 1852-53, when 120,000 were carried off. However, although this disease is more or less constantly present in every part of India, yet in most districts only a few villages are attacked each year, so that the odds against any particular village in which the disease may be found being attacked again within the next ten or twenty years may be great, and consequently experience may prove that an immunity which is sufficient to check any particular outbreak, say, one of a few months' duration, is all that is required. Once more the breeds of cattle in South Africa differ widely from those of India, and those of the latter country differ widely from each other, so that, before carrying out methods of inoculation on a large scale, careful experiments are required. For instance, it is well known that when the disease appears among Hill cattle, it is usually of a very virulent nature, and may carry off as much as 90 per cent. of the animals attacked, while in the Plains it is not as a rule nearly so fatal. In correspondence with this difference in susceptibility it has recently been found in this Laboratory that Hill cattle require a much larger dose of serum weight for weight for their protection than do Plains cattle, so that the whole question requires to be carefully tested experimentally before final conclusions as to the best method to adopt in this country are come to.

Taking into consideration the above mentioned points, it may be said that what is most wanted is a method which will produce an immunity as rapidly as possible, as the outbreaks will seldom be reached until they are at their height, while, if it is to gain the confidence of the villagers, care must be taken not to run any risk of any material mortality among the inoculated cattle, or of a too severe degree of illness, even at the expense of a less durable immunity, which is of much less importance in this country than it was in South Africa, for the reasons already pointed out. The religious susceptibilities of the people must also be reckoned with, and for this reason alone the bile method of Koch, which necessitates the slaughter of some 7 per cent. of the animals, at from the sixth to the eight days, in order to obtain bile for the protection of the others—a protection, moreover, which is only a temporary one,—is practically out of the question in India. I am aware that this difficulty may be overcome to some extent by the use of buffaloes for obtaining the bile from, but this involves a further loss of time in obtaining and inoculating these animals if there are none of them affected in the village, while both the expense and the period before the immunity is produced will be much greater than in the serum method. The glycerine bile method gets over the difficulty of slaughtering animals, but at the expense of a still greater delay, as after the bile has been obtained it must be glycerinated and kept for eight days, and ten days later again the animals must be inoculated with a small dose of virulent blood, and are still susceptible to natural infection for some days longer,—a very serious drawback, for it is usually quite impossible to separate the infected from the uninfected animals in an efficient manner in Indian villages. The necessity of inoculating all the animals a second time ten days later will also be a serious drawback in Indian villages where the simplest possible method will be most likely to win the confidence of the inhabitants.

It would appear, then, that if the results obtained in South Africa are confirmed in India, that the serum method, or a modification of it, so as to give but

a very slight attack of the disease with a sufficiently long consequent immunity, will be best suited to the conditions met with in this country; especially as the protection will be obtained in a very few days. Moreover, the serum in larger doses can be used as a curative measure in early cases of the disease, if a sufficient quantity is available,—a matter of the greatest practical importance. All these methods are, therefore, being tested in this Laboratory and the results as far as they have yet been obtained will be now given, although it should be said that the experiments are not yet far enough advanced to allow of any definite conclusions being arrived at on any of the methods enumerated above, and a special report on the subject will be submitted when they are completed.

Summary of Experiments on Rinderpest as yet carried out.

18. *Pure unfiltered bile.*—An animal was inoculated with 10 c.c. of good green bile, and on the tenth day was tested with an injection of 10 c.c. of virulent blood. No disease followed. This animal died of colic on the twenty-fifth day, and on making a *postmortem* well-marked lesions of rinderpest were found in the fourth stomach, and less marked ones in the cæcum. This is very interesting as showing that the animal had actually suffered from a mild attack of the disease, although he had never presented any definite rise of temperature or symptoms of the disease throughout the time he was under observation, the temperature having been taken twice daily. Whether the disease occurred after the injection of bile or after the virulent blood it is impossible to say, but such a case may explain the occasional unusually long duration of the immunity after the bile inoculations.

A series of animals have been inoculated with bile, and will be tested at intervals in order to determine the duration of the immunity which may be expected to result in Indian cattle from the use of this method.

19. *Filtered bile.*—As so many observers in South Africa have found that virulent rinderpest sometimes follows injections of bile, it was decided to test the immunising properties of bile that had been passed through a Pasteur filter and so deprived of all chance of the danger of conveying the infection to the inoculated animals. Several animals were inoculated with different doses of filtered bile, and subsequently either inoculated with virulent blood or exposed to natural infection in a shed containing animals in an active stage of the disease. All the animals contracted the disease in various degrees of severity, some dying of it, although in a smaller proportion than control animals which were inoculated with virulent blood only. It appears, then, that only a very slight degree of protection is afforded by this method, and that it is of too uncertain a degree to allow of cattle, any rate of the Hill breeds, being safely passed through a mild attack of the disease by first inoculating them with filtered bile and subsequently with a small dose of virulent blood. Since these experiments were carried out a paper has been received in which similar experiments in South Africa were reported to have yielded identical results, so that it appears to be useless to pursue this question further, unless better results are obtained in Plains cattle which have not yet been treated in this way.

20. *Glycerinated bile.*—This method has also been tested, but so far without success. Five animals were inoculated with the same dose as is recommended by Dr. Edington for the large South African cattle, which is more than three times that which would be required in these small Hill animals if their weight is taken into account. Two of these animals unfortunately developed a naturally acquired disease in less than ten days, and another on the tenth day, and all died. Two others were inocculated with 1 c.c. of virulent blood on the 14th day, and both developed severe attacks of the disease, one dying and the other very nearly so, showing that no protection had been afforded. As it was afterwards found that Dr. Edington advises that only 0·2 c.c. of blood should be used for the second inoculation, six other animals were inoculated with the dose of glycerinated bile recommended by him, taking into account the weight of the animals, and on the tenth day they were reinoculated with 0·2 c.c. in accordance with his directions; but five of them died of rinderpest and the other was very ill. This method, then, does not appear to be successful in

Indian Hill cattle, but it will have to be tested on the less susceptible Plains ones in whom it may possibly give better results. As, however, in point of susceptibility to the disease the Indian Hill cattle are more on a par with the South Africa animals than are the Indian Plains cattle, the results so far obtained are disappointing, and it appears to be an example of the differences among various breeds of cattle with regard to the ease or difficulty of affording them protection from the disease by various methods.

21. *Liver extracts.*—As the protective substance in rinderpest bile, whatever it may be, must be secreted by the liver, it seemed possible that it might also be present in the liver substance after death in perhaps still larger quantities, and in that case, if it could be made use of for protective inoculation, the number of cattle that might be protected from material obtained from one rinderpest animal might be materially increased. It was recognised that the liver would also contain a large amount of the infective material, but it was hoped that this might be eliminated either by keeping it for some time or by filtering the liver extract through a Pasteur filter.

An animal was first inoculated with a dose of the extract from the liver of an animal which had died of rinderpest, and which had been kept for three days in ice, and, as was expected, rinderpest ensued and proved fatal. Another animal was inoculated with a dose of the same liver extract which had been kept in ice for eleven days. Rinderpest again ensued and caused death. Two other animals were inoculated with different doses of liver extract which had been passed through a Pasteur filter. No reaction ensued, and on inoculating one with virulent blood subsequently, and exposing the other to natural infection, both took the disease severely, and one of them died. The unfiltered extract, then, produced the disease after being kept for eleven days, while the filtered extract produced little or no protection. The results of the use of filtered bile mentioned above explains the failure to obtain protection in this latter way.

22. *Bile from a salted animal.*—An animal which had been protected by the simultaneous method of inoculation and had subsequently received increasing doses of virulent blood, the last being 500 c.c., unfortunately died of acute Bright's disease, so the opportunity was taken to test if his bile contained any antitoxic properties.

An animal was therefore inoculated with 50 c.c. of the bile on one side of the body and 1 c.c. of virulent blood on the other side, after the method of simultaneous inoculation. The animal contracted a virulent attack of the disease and died. As, however, the beast was a Hill one, which it was subsequently found required a very much larger dose of the serum weight for weight then do Plains cattle, the quantity of bile used was not as great as would have been required of the serum of the same animal at this stage of salting to have certainly protected a Hill animal from the disease; so this experiment cannot be taken to prove that the bile of a salted animal does not contain the protective material.

Another animal was injected with 20 c.c. of the same bile as that used in the last experiment, but no protection was afforded by it. It appears from this that, although the animal from which the bile was taken had a very fair temperature reaction after he was injected with 500 c.c. of virulent blood, but showed no symptoms, nevertheless no very active protective material was being secreted by his liver as occurs during an actual attack of the disease. As it had been found that during the course of these injections of virulent blood into immune animals, their blood contains the active infective material, as shown in experiments mentioned in paragraph 24 by its injection into a healthy animal producing the disease, it might have been thought that the bile would have contained the protective material, but this appears not to be the case. The point is, however, only of theoretical importance, as such animals are far too valuable as serum producers to be available for furnishing bile.

23. *Preservation of the infection in blood.*—These experiments were undertaken partly to see if any attenuation of the virus could be obtained and partly to see how long the virus could be preserved in blood from an infected animal kept under different conditions.

A small quantity of blood was placed in a glass bulb, and hydrogen gas having been passed through the tube to expel all the air, it was sealed up

and kept at the room temperature, which at that time was only from 4° to 10° centigrade. Some of the same blood was put up in a similar tube from which the air was not expelled before it was sealed up. In the first experiment, blood which had been thus put up four days after it was obtained from the animal and kept for eleven days more under the same conditions was used, and both that in hydrogen and the control blood in air produced a severe and fatal attack of the disease. In a second experiment, with the same blood which had been kept under the conditions noted for twenty days, the result was negative, but in a third series, blood which had been put up in hydrogen for nineteen days caused a severe and fatal attack of rinderpest when injected subcutaneously, but some of the same blood which had been sealed up without removing the air gave the same result.

It appears, then, that hydrogen gas had no effect either in preserving or in attenuating the virus over ordinary air. The length of time which the blood remained virulent was also uncertain, but might be considerable, and as it has recently been found that difficulty is sometimes met with in villages in getting the consent of the people to allow the small quantity of virulent blood that is required for the simultaneous method of inoculation to be taken from any of their sick cattle, these experiments will be continued ; for, if a method of preserving the virus for two or three weeks without loss of virulence can be discovered, it may be found possible to keep such a supply of virulent material at the Bareilly Experimental Station when that place is completed. Dried rinderpest blood is also being tested.

24. *Inoculation of blood from animals in different stages of salting.*—In the process of making protective serum, large doses of virulent blood in increasing quantities are injected into animals which have recovered from the disease, with the result that only a temperature reaction without symptoms is produced. It appeared to be likely that the virus was modified in some way in this process, and although it was probable that its intensity would be increased on account of the resistance that it would meet with from the antitoxine or other protective substances already produced in the animal's body by its reaction to the virus, rather than reduced, yet the question seemed to be worth testing.

A series of animals were therefore inoculated with blood obtained from animals at different periods after injections of large doses of virulent blood subcutaneously. It was found that if the blood was taken after the reaction was over and the temperature had fallen to normal, no effect was produced. If, on the other hand, it was taken after the reaction had begun and up to the time it attained its height, the disease was always produced, but if the temperature was on the decline it was uncertain whether the disease would be produced or not. The blood of salted animals, then, during the period of the reaction contains the virus in an active state. With regard to the question as to whether any modification of the virus was brought about, it was found that the disease produced was always severe, and never in any degree modified. On the contrary, an analysis of the figures shows that the incubation period, and to a less marked degree the duration of the disease before death ensued, were shorter in the case of the animals which were injected with blood from salted animals while reacting than in the case of controls injected with the blood of ordinary inoculated rinderpest animals.

In some of these cases the blood was injected directly into a vein, and in these the incubation period was a day shorter than when the same blood was inoculated subcutaneously into another animal, and the duration of the disease was also shortened by one day. This point is of some practical importance, as when a quantity of virulent blood is wanted urgently for the serum-producing inoculations, it can be obtained a day sooner by inoculating the control animal intravenously instead of subcutaneously.

25. *The preparation of the protective serum.*—The reports of the successful application of the serum method in South Africa having reached the Laboratory just as preparations were being made for the commencement of the experiments on rinderpest here, it was at once recognised that this method was likely to be more suitable to the conditions of the disease in India than the former bile ones, and arrangements were at once made for the preparation of the serum in considerable quantities. Fortunately, too, just at this time the

out buildings of the Laboratory were practically completed, and four salted animals, which had recovered from an attack of the disease at the time of the experiments made when Professor Koch visited the Laboratory 18 months before, were available for the purpose, and were inoculated with increasing doses of virulent blood until 1,000 c.c. were given at once, and were then bled for the production of serum and reinoculated again with still larger doses, in accordance with the details described by Turner and Kolle. Subsequently, some of the serum obtained from one of these was used for passing six more animals through a mild attack of the disease, and these too were then inoculated in the same way as the first series and serum obtained from them, so that at the present date some 30,000 c.c. of serum have been made. When a centrifugal machine, which has been ordered, reaches the Laboratory, more than twice as much serum will be able to be prepared from the same quantity of blood as is at present possible. It is worthy of note that in all our first bleedings only from 11 to 15 per cent. of serum was obtained from the blood taken, which was very disappointing. As it seemed probable that the quantity that separates from the clotted blood would depend on the firmness of the clot itself more than on any other factor, and as, moreover, it is known that the clotting power of the blood can be very materially increased by the administration of Calcium Chloride, it was determined to administer this drug before bleeding the animals. The result was most satisfactory, as in this way from 30 to 40 per cent. of serum was obtained, and the great difference between the quantity obtained from animals with and without the use of the drug was repeatedly verified, as different animals were found to give different quantities of serum. Moreover, it was found that a greater quantity of serum was obtained by the use of two doses, each of half an ounce, one given the evening before and the other on the same morning as the bleeding but some three hours before, than by a single dose given on the same morning as the blood was taken. All our animals are now treated in this way, and there is no evidence to show that the quality of the serum is in any way affected by the drug, while, if anything, it might be expected to lessen the uticaria which sometimes follows the injections of the serum.

One other point of practical importance, which has been worked out in the course of these experiments on making serum, may be mentioned here. The main difficulty in carrying it out is that of obtaining of large quantities of virulent blood, for which purpose control animals have to be inoculated and subsequently bled when the disease has fully developed. As, for the sake of economy, the small Hill cattle are used for this purpose, it was found that only some 2,000 c.c. of blood could be obtained from the jugular vein of an animal before heart failure set in, the flow ceased, and the animal shortly after died. On the other hand, by bleeding from the carotid artery, only 3,000 c.c. were obtained, but the process was a peculiarly repulsive one, convulsions being caused. In South Africa very much larger animals are used, and although they are bled to death a very much larger quantity of blood is obtained from one animal, and the process does not require to be repeated nearly so often as would be the case when Hill cattle are used in India. Moreover, on account of the sacredness of cattle in India, it is eminently desirable to avoid bleeding this animal to death, but if the amount taken is so regulated as to allow of the animal going back to his stall and living for a time at least, but very little blood is obtained and the number of animals sacrificed is greatly increased.

Fortunately, a method of overcoming both these objections has been put up into pratice with most satisfactory results. It consists simply in the injection into the jugular vein, after taking as much blood as is required, of an equal quantity of sterilised salt solution of the same specific gravity as the blood itself, such as is used in the case of transfusion after severe hœmorrhages. In this way the circulation is restored, and it has been found that 2,000 c.c. of blood can be easily obtained and still the animal walks back to its stall as if nothing had been done to it, and in fact animals so treated appear to have a better chance of recovery from the disease than those which are not bled. Moreover, two days later the process can be repeated and the same quantity taken, and yet the animal will again walk back to its stall and often live for some days longer, although when such large quantities are repeatedly taken, the animal seldom recovers. In this way much larger quantities of blood can be obtained,

for the process could be repeated a third time, or larger quantities taken the second time if thought advisable, and at the same time the slaughter of the animal if avoided. This method has considerably reduced our difficulties in preparing large quantities of serum, and at the same time has lessened considerably the number of animals which it has been necessary to inoculate with the disease for the purpose of obtaining virulent blood.

26. *Testing the strength of the Serum.*—As before the serum can be used in outbreaks, its strength has to be tested on a series of animals in order to find out exactly what dose per given body-weight must be used together with a small dose of virulent blood injected into a different part of the body, in order to produce a mild attack of rinderpest, with subsequent immunity for life; 18,000 c.c. of serum were recently mixed together and tested in this way on eight Hill cattle and four Plains ones in four series, each series receiving a different dose in proportion to their weights, and the remarkable result was obtained that, although all the Plains cattle, including the one which had the smallest dose, namely, 15 c.c. per 600 lb weight, remained without any marked symptoms of the disease, although two of them had distinct temperature reactions, yet all the Hill animals developed the disease and all but one died of it. A similar result was obtained when the six animals were salted for subsequently obtaining serums as mentioned above, for all the Plains animals had but little reaction, while two Hill cattle which were inoculated in the same way died of the disease, although weight for weight they had received a rather larger dose of the protective serum than the Plains ones. Other Hill cattle have since been tested with larger doses of the serum, and successfully passed through a mild attack of the disease, 45 c.c. per 600lb being the dose required for the purpose.

It appears, then, that there is a very great difference in the susceptibility of Hill and Plains animals, and this fact raises the important question as to whether there may not be a considerable difference in the liability of different breeds of Plains cattle in different parts of India, and renders it necessary to carry out the simultaneous method of inoculation in several outbreaks with great caution before coming to a final conclusion as to the value and practicability of this method in India. With further experience it is expected that a still more powerful serum than the above will be made here.

27. *Inoculation in affected villages.*—A visit was paid to some affected villages in Bareilly during the end of April and the beginning of May in order to carry out this method, and although the disease in most of the villages was found to be on the decline on account of the recent rapid increase in the temperature, yet one village was found in which, out of 145 animals, 73 had been attacked and 24 had died. Here the villagers readily assented to inoculation of the healthy cattle and allowed me to take some blood from one of the diseased animals for the purpose. Twenty-four animals were inoculated in this village in the course of a morning's work, the dose of serum used was 30 c.c. per 600lb weight, being twice that which had proved sufficient in the case of Plains cattle at Muktesar, so as to be on the safe side, and not to run any risk in case the animals were more susceptible than the Muktesar ones of developing a severe attack of the disease. I revisited this village six days later and found that none of the inoculated animals had developed any very marked symptoms of the disease, which were evident to the villagers, while out of 39 uninoculated, 9 had become affected and 2 had died. On closely examining the inoculated animals 8 of them were found to have very slight symptoms of the disease, and will probably be protected for a long time, while the rest should (in accordance with South African experience, which has not yet been confirmed in India, but which is being tested at Muktesar), be rendered insusceptible for several months at least. One of the Veterinary Assistants visited this village again two weeks after the inoculations were carried out, and found that all the inoculated animals were still free from the disease, but one more of the uninoculated had died of rinderpest and the disease had very nearly died out. As from inquiries in these villages it appears that any individual one is rarely attacked oftener than once in twenty years, this degree of immunity should be sufficient to carry them over the present outbreak, and these cattle are not likely to be attacked again with the disease within their life-time, which is all that is necessary.

If this experience is confirmed in future outbreaks, the method here adopted—of using a large enough dose of serum to prevent the animals being made markedly ill, and yet obtaining a sufficient degree of immunity for all practical purposes,—will be of very great value in India, especially as the dose used was only about 20 c.c. on the average, and the immunity is produced within a very few days. It is worthy of note that on my revisiting this village I found the people so pleased with the result of the inoculations that they brought up some more cattle to be operated on, showing they were impressed with the value of the method.

In another village the disease was found to be on the decline, and only five animals were reported to have died of it. In one herd of seven animals, however, two were found to be affected, and with the consent of their owner the five healthy ones were inoculated. When the village was revisited about a week later none of these inoculated animals had been attacked by the affection, and they also should be protected by this time. As they were exposed to infection the whole time from the two diseased animals, which remained with them, it is probable that some at least of them were saved from the disease by the inoculation.

In addition to the above, two animals, which were in the early stages of the disease, were inoculated with a considerable dose of the serum as a curative measure, and both recovered, the owners saying that the improvement set in one day after the dose in one animal and two days after in the other. This curative serum treatment will be more fully tested shortly when a larger quantity of the fluid is available,, but it must be remembered that it is only of service in the early stages of the disease, and as with the same dose that is required for the treatment of one case in this way, some ten animals may be protected by the simultaneous method of inoculation, there is a very definite limit to the use of the serum in this way owing to the great difficulty in making it on a sufficiently considerable scale for extensive use in such large doses.

28. *Conclusion.*—It will be seen from the above notes that considerable progress has been made in testing the various methods of inoculation against rinderpest, and although a good deal of work remains to be done on the subject, the experiments promise to lead to the adoption of a practical method of diminishing very materially the great mortality from rinderpest in this country, when once a final decision is come to and a sufficient organisation is obtained to put into practice the invaluable methods for which we are indebted to South African workers.

Report on the duration of the infection in the skins and bones of animals that have died of rinderpest.

29. *Methods of curing hides in different parts of India.*—Before examining into the question of the duration of the infection in rinderpest hides and the danger of such infection being carried in the skins of animals that had died of the disease from one part of the country to another, or possibly from India to other countries, through the export of cured or tanned hides, it was necessary to know the way in which such skins are treated in different parts of the country preparatory to being taken to towns where they are tanned or from which they are exported with or without further treatment. For the following information on this head I am indebted to Dr. Watts, the Reporter on Economic Products to the Government of India, who very kindly made inquiries for me from the different Chambers of Commerce and the principle dealers in hides, and sent me copies of their replies.

As it seemed very likely, if not absolutely certain, that the process of tanning would destroy the infection of rinderpest, it was decided to first test the various methods of drying and curing hides, for, if these were sufficient to destroy the infection within a reasonable period, then it would be quite certain that tanning would also render them inocuous, and further inquiry would be unnecessary.

The processes of curing the hides of cattle and buffaloes, with which only we are concerned, appear to be much the same all over India, and are three in number:—

(1) Simple drying of the skins, usually in the sun, but in the rainy season they may have to be dried in the shade.

(2) Salting the hides, for which purpose common salt is used in many places, and especially in the Punjab, while in Bengal and also in the North-Western Provinces "Khari," which consists of Sodium Sulphate with a little Magnesium Sulphate and a very small quantity of Sodium Chloride, is largely used instead of common salt, although less so than was formerly the case. This last material has the advantage of being less deliquescent than common salt, so that the hides dry more quickly, and for this reason it is pretty certain that hides cured with ordinary salt would contain the infection a little longer, if anything, than the Khari-treated ones, and if the former is sufficient to render the skins inocuous, the latter will have the same effect.

(3) The third process consists in the use of Chunam (lime) which is rubbed into the skin just as salt is.

The details of these methods differ very slightly in different provinces. Thus, in Calcutta, the skins are often dried with or without the addition of salt or lime, then dipped into a bath of salt and lime, and finally dried once more. Another process is also largely used there at the present time, which consists of placing skins, which have been dried in the sun without the addition of any ingredient, in a bath of arsenic and ammonia or soda for a few minutes, and then drying them again, the arsenic remaining in the skin and protecting it from the ravages of insects, for which purpose it is used and not as an antiseptic. Arsenic is also largely used by European dealers in the North-Western Provinces, but here again the skins are first dried in the sun, so that, if that alone proves sufficient to prevent all danger of infection, it will not be necessary to test the action of arsenic on the contagion. In Bombay, nearly all the skins are tanned after salting or drying, while in Madras they are either tanned straight away while fresh, or, if they have to be kept more than 24 hours, they are first treated with lime or salt. Raw hides in this province are dried in the sun. At Karachi the skins are either dried in the sun for two days or treated with arsenic and then sun-dried. In the North-Western Provinces, between October and May, the skins are sun-dried on bamboo frames, while from June to September they are salted, usually with Khari salt from Patna. Those which are taken from dead animals are sun-dried. In Western Bengal they are either sun-dried or treated with Khari, while in Lower Bengal the latter process is largely used.

It will then be evident that, in order to ascertain whether there is any danger of rinderpest being carried about India or to other countries through the export of the hides of animals that have died of rinderpest, it will be necessary to find out how long the infection remains in the hides of animals, that have died of this disease, when they are either dried in the sun or shade, or treated with salt or lime, and with this object in view the following experiments were made.

30. *Methods of carrying out the experiments.*—As hides are well washed to free them from blood, after all adherent muscle has been carefully removed, and even the infection of blood, which contains the contagion of the disease in the largest quantity, is soon destroyed by complete drying, it is unlikely that the surface of dried skins would carry the infection of the disease; but nevertheless in the interior of them the contagion might possibly live for some time in the blood vessels within the skin, and under favourable circumstances might cause infection. Again, the disease is usually conveyed through the nostrils or mouth of the animal, by infectious substances coming into contact with them, but the disease can be conveyed with still greater certainty by the introduction of the virus under the skin. It was, therefore, decided to make an extract of the small pieces cut out of the skins in sterilised physiological salt solution (one which contains the same amount of salt as the blood), and to inject this beneath the skin of a susceptible animal,—a most severe test, and one which if it failed to produce the disease may be safely taken as evidence that there is no living contagion remaining in the skins so tested, and hence they could under no circumstances convey the disease. Skins were also placed in the feeding troughs of animals and were licked by them, which would be the ordinary way in which the disease might possibly be communicated if the skins were infectious. As in consequence of other important experiments that were going on at the same time, we could not afford to run any risk of infecting our healthy sheds, the earlier experiments had to be

carried on in one in which cases of the disease had occurred, and although careful disinfection was carried out, in some instances the animals became infected from others in the same shed, mostly at a date which was beyond the incubation period of the disease, so that it was certain that the infection was here a natural one, caught from the infected sheds and not from the skins which were being tested, and only proved that the animal was susceptible to the disease and yet had failed to get it from the skin injections within the extreme known incubation period of the disease. I should also mention that all of the animals which did not get the disease from the skins were subsequently injected with virulent blood and proved to be susceptible by their contracting the disease in every case except one, and this solitary exception was also given at the same time a large dose of protective serum, which was sufficient to prevent him contracting the disease. In every fatal case the diagnosis I was confirmed by a *post mortem* examination. Moreover, all the cases which natural infection followed the skins injections in the infected shed were subsequently controlled by a final experiment in a shed in which no cases of rinderpest had ever occurred. The temperatures, pulse and respirations of all the animals were taken twice a day and recorded on a chart, together with the symptoms for ten days after the injection, while the extreme incubation period of the disease mentioned in the reports from South Africa is eight days, and I have never seen it to be as long as that in any animals tested in this Laboratory. The animals used were all Hill cattle, which I find are much susceptible to the disease than Plains animals. The sun temperature at the place where the skins were being dried was recorded with a solar radiation thermometer three times a day, and the shade maximum and minimum temperatures were also recorded together with other meteorological data, and it will be seen from the records given with the experiments that these temperatures are lower than would be likely to be met with in most Plains stations at any time of the year, so that the length of time that was found necessary in the different processes for the destruction of virus in the hides tested at Muktesar will be at least as long as, if not longer than, would be required in the Plains, so that the results obtained here may reasonably be held to apply to all those parts of India in which there is any material trade in hides.

The experiments were carried out in three series, the first of which only applied to dried skins and were undertaken to get a general idea as to the probable duration of the infection, while, as the skins had been kept in the *post mortem* house until shortly before they were used, which is, perhaps, the most infected spot in the place, it was recognised that some of them might have become recently reinfected from the place where they had been kept, and the test was of more negative than positive value. The second series was carried out with skins that had been treated by a professional native Chamar (hide curer) with skins which were kept in an uninfected room and hung up separately from each other. The third series were carried out in the same way as the second series, only in an uninfected shed. The results of each experiment will now be briefly recorded.

First Series of Experiments.

31. *Experiments No. I.*—A small bull, aged 5½, was injected subcutaneously on March 4th, 1899, with 10 c.c. of an extract made with normal saline solution (0·6%) of small pieces of the hide of a bull that had died of inoculated rinderpest on February 12th. The skin had been dried in the sun for 18 days, during which time the maximum temperature in the shade had varied between 51° and 60°F., and the minimum temperature between 34° and 44°F.

Result.—The temperature, pulse and respiratory curves remained normal for ten days and no symptoms of disease appeared. This animal was subsequently used for another experiment and contracted rinderpest and died of the disease, proving that his failure to become infected by the skin extract was not due to insusceptibility to the affection.

Experiment No. II.—A small bull, aged 1½, was inoculated subcutaneously on March 4th with 8 c c. of an extract of the hide of an animal which had died of inoculated rinderpest on February 5th, and which had been allowed to dry in the *post mortem* room with other skins for 26 days, during which the maximum temperature in the shade had varied between 38° and 60°, and the minimum between 28° and 44°F.

Result.—The temperature rose on the fourth day, *buccal vesicles* and ulcers, a watery discharge from the eyes and nose, and diarrhœa with passage of mucus occurred, and he died of rinderpest on the 9th day, the diagnosis being confirmed by a *post mortem* examination.

Remarks.—As already pointed out, this skin had been exposed to the chance of reinfection by being kept in the *post mortem* room in which autopsies were being performed almost daily, so that it is open to question whether the infection really remained alive in this skin for 26 days, and the result of later experiments showed that this could not have been the case, as other skins had lost their infection in far shorter periods, and the skin had probably become reinfected or the animal contracted the disease from the shed in which he had been placed.

Experiment No. III.—A small bull, aged 2½, was inoculated subcutaneously on March 4th with 10 c.c. of an extract of small pieces of hide of an animal which had died of inoculated rinderpest on the night of the 20th February, and which had been dried in the sun for ten days, during which time the maximum temperature in the shade had varied between 51° and 60°, and the minimum between 37° and 44° F.

Result.—The temperature, pulse and respiratory curves remained normal for ten days and no symptoms of disease appeared. This animal was subsequently used for another experiment and contracted rinderpest and died of the disease, proving that he was susceptible to the infection, and if the skin had contained the living virus he would have contracted the disease.

Remarks.—These three preliminary experiments proved that skins that had been dried in the sun for from 10 to 20 days no longer contained the germs of the disease, but left it in doubt as to whether a skin which had been kept in an infected room had retained the infection or had been reinfected by its unfavourable surroundings.

Second Series of Experiments.

32. *Experiment No. V.*—A bull, aged 6 years, was inoculated subcutaneously on the 15th March with 10 c.c. of saline extract of small pieces of the skin of an animal, which had died of inoculated rinderpest on the 28th February, and which had been dried in the sun for four days, during which the maximum temperature in the shade varied between 40° and 61° F. and the minimum between 39° and 41°, while the maximum registered by the solar radiation thermometer (blackened bulb thermometer invacuo) was on each day respectively 126·6,° 135°, 128·8° and 129·4° F.

Result.—The temperature, pulse and respiratory curves remained normal and no symptoms appeared for 8 days, but two other animals in the same shed, belonging to a different set of experiments having contracted the disease in the meanwhile, this animal's temperature rose on the ninth day and a typical attack of rinderpest, from which he died, ensued.

Remarks.—In this case natural infection contracted from other diseased animals occurred just after the limit of the incubation period after the skin extract injection had elapsed, showing that the animal was susceptible to the disease, but the skin was no longer infectious after being dried in the sun for four days, and kept in a room for ten days more.

Experiment No. VI.—A bull aged 1½, was inoculated with 10 c.c. of a saline extract of small pieces of a skin of an animal which had died of inoculated rinderpest, which had been treated with common salt well rubbed into it and placed in the sun for two days until it was dry, and then kept hung up in a room for twelve days more. This was part of the same skin as was used in experiment No. IV, so that the temperature conditions were identical with those given above.

Result.—The temperature, pulse and respiratory curves remained normal for nine days, and no symptoms of disease appeared during that period of time, but on the tenth day the temperature rose and fatal rinderpest ensued, doubtless due to natural infection from other diseased animals in the same shed, as occurred in the case of experiment No IV, described above. The disease appeared after the extreme incubation period had already elapsed since the injection of the skin extract.

Experiment No. VII.—A bull, aged 3½, was inoculated with 10 c.c. of an extract of small pieces of skin from an animal which had died of inoculated rinderpest, and which had been treated with chunam (lime) and placed in the

sun for two days, and then kept for 12 days hung up in a room. The temperatures during the period of drying were those given in experiment No. IV.

Result.—The temperature rose on the ninth day, and the animal had suffered from a typical attack of rinderpest which terminated fatally on the ninth day of the disease.

Remarks.—Here again the animal was exposed to natural infection from the day after he was inoculated, owing to two other animals of a different series of experiments contracting the disease in the same shed. As the temperature rose on the seventh day, which is just within the extreme limit of the incubation period given by South African observers, although a longer one than I have ever seen in the inoculated disease in India, it is just possible that he got the disease from the skin extract injection, but the experiment to be related presently in the third series, in which a lime-treated skin of a more recent date than the one used in this experiment failed to convey the disease in an uninfected shed, taken together with the unusually long incubation period of the disease, point strongly to the infection in the case under discussion having been due to close relationship with other diseased animals, and not to the virus having been preserved in the lime-treated skin.

Experiment No. IX.—A bull, aged 4, was inoculated with 10 c.c. of saline extract of the skin of an animal that had died of inoculated rinderpest, and which had been dried in the shade for 28 days, during which the maximum temperature in the shade had varied between 47° and 69°, and the minimum between 34° and 50° F.

Result.—The temperature, pulse and respiratory curves remained normal for 10 days, and no symptoms appeared during that period of time, but the animal having been left in an infected shed soon afterwards contracted the disease naturally, showing that he was susceptible to it, but that the skin in question did not contain the virus.

Remarks.—This second series of experiments, then, showed that a skin which had been dried in the sun for four days and kept ten days more was void of infection, as were other portions of the same skin which had been similarly treated, only with the addition of salt, while a part which had been treated with lime gave doubtful results, owing to the shed in which the animals had to be placed having been previously infected. Another skin which had been dried in the shade gave negative results after one month.

Third Series of Experiments.

33. *Experiment No. X.*—A bull, aged 1½, was inoculated on April 3rd with a saline extract, 5 c.c, of the skin of an animal that had died of inoculated rinderpest, and which had been dried in the sun for two days and then kept in a room for six days more. The maximum and minimum shade temperatures during the two days the skin was drying were 74°, 75°, 53° and 51° F., respectively, while the maximum registered by the solar radiation thermometer on the same days were 141° and 157° F.

Result.—The temperature, pulse and respiratory curves remained normal for ten days and no symptoms appeared. The animal was subsequently inoculated with virulent blood in another shed and contracted the disease, showing that he was susceptible to it, but that the skin used was free from infectious properties.

Experiment No. XI.—A small bull, aged 5 years, was inoculated subcutaneously with 5 c.c. of an extract of the skin of an animal that had died of rinderpest, and which had been dried in the shade for two days, and kept hung up in a room for eight days more. The maximum temperature in the shade during the three days when the skin was being dried was 68°, 72° and 70°, respectively, and the minimum temperatures were 53°, 50° and 51° F.

Result.—The temperature, pulse and respiratory curves remained normal for ten days, while no symptoms appeared. The animal was subsequently inoculated with virulent rinderpest blood and died of the disease, proving that he was susceptible to the disease, and that the skin had lost all infectiousness.

Experiment No. XII.—A small bull, aged 6, was inoculated subcutaneously with a saline extract of small pieces of the skin of the same animal as was used in experiment No. XI, and which had been treated with lime in the shade for two days, and then kept in a room hung up for eleven days more.

Result.—The temperature, pulse and respiratory curves remained normal for ten days, and no symptoms appeared. The animal was subsequently

inoculated with rinderpest blood and suffered from an attack of the disease, showing that he was susceptible to it, and that the skin used no longer contained the virus.

Experiment No. XIII.—A bull, aged 4 years, was inoculated subcutaneously with 5 c.c. of a saline extract of small pieces of the skin of an animal which had died of rinderpest, which had been treated with salt in the shade for two days, and then hung up in a room for 11 days more. The maximum and minimum temperatures in the shade were the same as in experiments Nos. XI and XII.

Result.—The temperature, pulse and respiratory curves remained normal for ten days and no symptoms appeared. The animal was subsequently inoculated with virulent blood and protective serum according to the simultaneous method, but the dose of serum being a large one, and sufficient to prevent the disease appearing, no symptoms ensued.*

Experiment No. XVI.—In the manger of a bull, aged 4 years, was placed a piece of the skin of an animal that had died of rinderpest, and which had been treated with common salt and dried in the shade for two days, and kept for eight days more hung up in a room. The animal was observed to lick the skin and was obliged to rub his nose against it in eating; it was left in the manger or feeding trough for eight days. The maximum temperature in the shade during the time this skin was being dried varied between 70° and 75° F., and the minimum between 50° and 54° F.

Result.—The temperature rose on the fourth day, but this was found to be due to an attack of congestion of the lungs, and soon subsided, no symptoms of rinderpest appearing during ten days. Owing to the lung inflamation the susceptibility of this animal to rinderpest has not yet been tested.*

Experiment No. XVII.—A piece of the skin of an animal which had died of rinderpest, and which had been dried in the shade for two days, and kept eight days more, the temperature conditions having been the same as in the two preceding experiments, was placed in the manger of a bull, aged 3 years, and left there for eight days. He was observed to lick it, and could not feed without his nose and mouth coming into contact with it.

Result.—The temperature, pulse and respiratory curves remained normal for ten days, and he was subsequently inoculated with virulent rinderpest blood, and developed a typical attack of the disease.

Experiment No. XVIII.—A piece of the skin of an animal which had died of rinderpest, and which had been treated with lime in the shade for two days and kept for eight days more, was placed in the feeding trough of a bull, and he was observed to lick it and must have come into contact with it when feeding. The temperatures during the period the skin was being dried were the same as in experiment No. XII, and it was left for eight days.

Result.—The temperature, pulse and respiratory curves remained normal for ten days and no symptoms of rinderpest appeared. The animal was subsequently inoculated with virulent blood and developed an attack of the disease, showing that he was susceptible to the affection, and that the skin used had lost all power of communicating the disease.

Experiment No. XIX.—A piece of a skin of an animal which had died of rinderpest, and which had been dried in the sun for three days, one of which was cloudy, and kept one day more. During the days it was in the sun the maximum temperature in the shade was 69°, and the minimum 47° F., while the maximum registered by the solar radiation thermometer on each day was 141° and 142°.

Result.—The temperature, pulse and respiratory curves remained normal for ten days, and no symptoms of rinderpest followed. The animal was subsequently inoculated with virulent rinderpest blood and developed a typical attack of the disease.

The above series of experiments prove that the skins of animals which have died of rinderpest, and which have been either dried in the sun or shade, or treated with salt or lime in the shade for two or three days, and then kept hung up in a room for a further period of from four to twelve days in the different experiments, no longer contain any infection even when submitted to the extreme test of extracts of them being injected under the skin of susceptible animals. Further skins treated in the same way, which were put in

* NOTE.—These two animals have been given rinderpest since the above was written, proving they were susceptible to the disease.

the feeding trough of the animals, and were licked by them, and which were in contact with their mouths and noses whenever they feed, for a period of eight days, also failed to convey the infection.

It is evident, then, that under the most favourabe circumstances it is scarcely possible for the infection of rinderpest to be carried by means of the skins of animals that have died of the disease for more than a very short distance, and that it is quite impossible that Indian hides, treated in any of the usual ways which are adopted in various parts of the country, could convey the infection of the disease to any country outside India through the exportation of raw untanned hides, and much more would it be impossible for those which had been passed through the lengthy and arduous process of tanning to so carry such infection.

34. *Infection in Bones.*—As there is a considerable traffic in the bones of animals, both in the different provinces of India, and an export trade in the same material, the question as to how long the infection of rinderpest can remain in them required to be tested. With regard to the surface of bones of animals which have died of rinderpest, as these will be covered with muscle and connective tissue, the facts recorded above with regard to the skin experiments will doubtless apply also to the coverings of the bones. On the other hand, the marrow in the shafts of the long bones would appear to be better suited for the preservation of the virus, as it was found to be still quite moist when a bone, which had been placed in the sun daily for six weeks during the months of January and February, was cut across, so that, although cattle could not well come into contact with such marrow under ordinary circumstances, yet it seemed to be worth testing, and as the results are of great interest, and also of some practical importance, the experiments will be briefly recorded here.

Experiment No. IV.—A bull aged 3 years was inoculated subcutaneously with an extract of 10 c.c. of the marrow from the shaft of the femur (thigh bone) of an animal which had died of rinderpest 37 days before and which had been placed daily in the sun except for a short period when snow was on the ground. The marrow was quite moist when the bone was cut across. The maximum temperature in the shade during the period when the bone was exposed to the sun varied between 31° and 60°F.

Result.—The temperature, pulse and respiratory curves remained normal for 10 days, and no symptoms appeared. The animal was subsequently inoculated with virulent rinderpest blood, and contracted a typical and fatal attack of the disease.

Experiment No. VIII.—A healthy bull was inoculated with 10 c.c. of an extract of the bone marrow from the femur of an animal which had died of rinderpest, and which had been placed in the sun daily for a period of one month, during which the maximum temperature in the shade had varied between 37° and 60° F.

Result.—The temperature began to rise on the third day, buccal vesicles and mucopurulent discharge from the nose appeared on the fourth day, diarrhœa and the passage of mucus on the fifth day, when the animal died, and the diagnosis of rinderpest was confirmed by a *post mortem* examination.

Remarks.—This animal was located in a shed in which another animal began to get symptoms of rinderpest the day after this one was inoculated with the bone marrow extract, but the first rise of temperature occurred within three days of the inoculation, and only two days after the other animal began to be ill. It appears to be extremely likely that the disease was actually produced by the bone marrow injection, and this probability is much strengthened by the further experiment recorded below.

Experiment No. XV.—A bull aged $1\frac{3}{4}$ years was inoculated subcutaneously with 5 c.c. of an extract of the marrow from the shaft of the femur of an animal which had died of rinderpest and which had been placed daily in the sun for 13 days. The maximum temperature in the shade during the time had varied between 66° and 75° F., and the minimum between 46° and 54°F., while maximum temperature in the sun recorded by the solar radiation thermometer varied between 131° and 157°F.

Result.—The temperature rose on the fifth day and remained high until the ninth day, when it fell rapidly and the animal died. Buccal vesicles and ulcers, purulent discharge from the nose, and diarrhœa with the passage of mucus, were noted during life, and after death a *postmortem* examination revealed the usual lesions of rinderpest.

Remarks.—As no case of rinderpest had ever occurred previously in the shed in which this animal was placed, there can be no doubt that in this case the disease was produced by the virus which had survived in the marrow inside the bone for two weeks, in spite of it having been daily exposed to a hot sun.

Experiment No. XIV.—A portion of the marrow of the same bone which was used in experiment No. XV recorded above, was smeared on the nostrils of a bull, aged $1\frac{1}{4}$ years.

Result.—The temperature, pulse and respiratory curves remained normal; no symptoms of disease appeared for ten days.

Experiment No. XX.—The femur of an animal which had died of rinderpest, and which had been placed in the sun daily for nine days, the temperature during which being the same as noted in experiment No. XV, was placed in the feeding trough of a bull, aged $2\frac{1}{2}$ years, and left there for eight days.

Result.—The temperature, pulse and respiratory curves remained normal for ten days, and no symptoms of rinderpest appeared during that period. He was subsequently inoculated with virulent rinderpest blood and contracted a typical attack of the disease.

Experiment No. XXI.—Some of the bone marrow from the femur of an animal which had died of rinderpest, and which had been placed in the sun daily for ten days, after which the marrow was taken out and placed in the sun for three days, two of which were cloudy, during which the maximum temperature in the shade was from 70° to 74°, the minimum from 41° to 53°, and the maximum of the solar radiation thermometer was 150°F., was placed in the food of a bull and was eaten by him.

Result.—The temperature, pulse and respiratory curves remained normal for ten days, and no symptoms appeared.

Remarks.—The above experiments are of considerable interest, for they prove, in the *first* place, that the virus remains active in the marrow inside the shaft of a long bone for at least two weeks, even when the bone is exposed to the sun daily during that time.

Secondly, they prove that the outside of the bone is rendered innocuous in a few days when placed in the sun, and that the marrow quickly loses its power of infection when taken out of the bone and exposed to the sun's rays. The failure of the same bone marrow, which caused infection when injected under the skin of an animal, to give the disease when it was rubbed on the nostrils of another animal, may be due to the fatty nature of the material preventing the germs of the disease from coming into sufficiently intimate contact with the mucous membrane to allow of infection to take place. In any case, as the only way in which the marrow of bones would be likely to come into contact with a healthy animal would be after they had been ground up and spread over fields as manure, in which circumstances the infection would very quickly be destroyed, even if this was done within a month, later than which the infection even inside the bone is lost, it is evident that there is no danger of animals becoming infected through the trade in bones.

The preservation of the infection in the marrow has, however, some practical importance from another point of view. One of the difficulties in carrying out both experimental work and inoculations in uninfected places lies in conveying virulent blood to considerable distances without its losing its power of infecting animals into which it is injected in order to produce the disease. This difficulty has been found to be a very real one in India owing to the high temperature through which blood had to be brought up to the Muktesar Laboratory on several occasions having caused a great loss of virulence. In South Africa, again, the difficulty has been of some importance, and was overcome by inoculating a sheep with virulent blood and then sending it several days' journey to the place where virulent blood was wanted, and then bleeding it, for it was found that the virus was preserved in the sheep without

his suffering from the disease. Now that it has been discovered that the virus can be preserved in the marrow of a long bone, even when the outside has been rendered non-infectious by exposing it to the sun for some days, it is evident that it will only be necessary to send such a bone to the place where virus is wanted, and to inoculate an animal from it. This method I hope to test in actual practice very shortly.

LEONARD ROGERS,
M.D., M.R.C.P., B.S., F.R.C.S.,
Captain, I.M.S.,
Officiating Imperial Bacteriologist.

G. I. C. P. O.—No. 126 R. & A.—14-7-99.—275—Jos. C.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1900-1901.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1901.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1900-1901.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1901.

CALCUTTA :
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1900-1901.

General Remarks.

I remained in charge of the Laboratory during the year under review and Veterinary Lieutenant G. K. Walker held the post of Assistant Bacteriologist.

2. No inoculation work was done in the field by the officers of the Laboratory, and a greater part of their time was occupied in manufacturing anti-rinderpest serum and despatching it to the Superintendents of the Civil Veterinary Department and other officers who demanded it. Appendix I shows this in detail.

3. In addition to the serum manufacture, the following diseases were dealt with during the year:—

(*a*) Rinderpest; (*b*) Anthrax, specially selected as causing more than any other destruction of cattle and other animals used for industrial purposes; (*c*) Surra; (*d*) Lymphangitis Epizootica; (*e*) Strangles, to the study of which circumstances have led my attention.

4. *Locust Disease Fungus.*—Propagation of this Fungus was continued at the Laboratory and 156 tubes were sent out during the year (*vide* Appendix II). It does not seem to have established its efficacy in India as it did in South Africa. The following are the brief abstracts of the reports received in this office:—

(i) The Political Agent, South Baluchistan, reports, "results unsuccessful."

(ii) The Deputy Commissioner, Bilaspur, says, "Cultures failure."

(iii) The Secretary to the Special Committee, Marwar, in his letter No. W & C 4-1673G, dated the 27th November 1900, to the Resident, Western Rajputana States, reports:

(1) "To a grown up insect humidity has been found to be the least congenial element of our weather conditions. It has also been ascertained that the fungus kills the insect to which it is applied but there its effects end. The body of the so-called insect if eaten by its fellow brethren carries no infection and unless the infectious nature is clearly established, its efficiency in exterminating locusts has but little practical value."

(2) Principal Suraj Prakash, M.A., who conducted these experiments in Marwar; concludes his report by saying, "so far my experiments lead to say that it is *moisture that* kills."

(iv) Captain Macdonald, Political Agent, Thal-Chotiali, says, "I have made up the poison and given the fungus myself, but I cannot say that the results are at all promising, and I think there can be little doubt that the climate of Baluchistan is so against this preparation as to render it almost if not quite, useless.

(v) The Assistant Political Agent, Thal-Chotiali, Duki, wires, "Experiments made with locust fungus already supplied have not been successful, please send ten more tubes immediately for further trial."

5. *Mallein.*—During the past twelve months 294 doses of English and French Mallein have been distributed to the Superintendents of the Civil Veterinary Department, as detailed in Appendix III.

6. *Bareilly Branch Depôt.*—Cattle-sheds, a Cinerator and a small working house have been finished and taken over. Arrangements are to be made for work to be carried on in this depôt during the ensuing cold weather, when it is hoped that the additional buildings will be in a sufficiently advanced state to permit of investigations, etc., being conducted there.

7. *Fodder supply.*—During the past cold weather few experiments were carried on in Muktesar, owing to the want of virulent rinderpest material. On this account our fodder supply was sufficient to meet the demand. This supply was obtained from our cultivation and surrounding forest, from the Muktesar garden which was transferred to the Laboratory at the commencement of this official year, and by means of the services of a contractor who collected it within a radius of 6 miles.

8. *Forest.*—During this year the working plan for Muktesar Reserved Forest was sanctioned by Government. The trees required for the supply of fuel and charcoal were marked by a qualified officer of the Forest Department, Naini Tal Division, and a systematic treatment of the reserve is in hand. A forest-guard has been sanctioned by Government to look after it.

9. *Meteorological Observations.*—The collection and record of these observations were continued. A copy of these has been regularly supplied to the Meteorological Reporter to the Government of India on the last day of each month.

10. *Staff and Establishment.*—The work of the institute has been much increased during the past year owing to the very large amount of anti-rinderpest serum manufactured in addition to the experimental inquiries undertaken with a view to produce protective sera for Anthrax, Surra and other diseases. It is most satisfactory to place on record the hearty co-operation I have received from the staff and establishment, which entailed continuous work on Sundays and leave days.

Experimental and research work.

11. In previous reports no clear working plan has been presented of operations in the Laboratory and in the field. This was impossible during the preliminary stages of primary investigation, but sufficient advance has now enabled me to develop during the past year a systematic scheme. The following are the sections of the scheme:—

I.—The diseases dealt with.
II.—The study and diagnosis of the selected diseases.
III.—The investigation of and progress made in preventive and curative remedies.
IV.—The Central Institution and its functions.
V.—The machinery existing and required for work in the field.
VI.—Actual work done in the field.

12. *Diseases dealt with during 1900-1901.*—These are enumerated in paragraph 3 of this report.

II.—*The study and diagnosis of the selected diseases.*

13. *Rinderpest.*—The study and diagnosis of Rinderpest has required little fresh study, the character and symptoms of the disease having been fully worked out in Europe.

14. To *Anthrax* the same remark as stated for Rinderpest, applies. The only thing wanted is that officers, especially natives, should be taught to distinguish Anthrax and Anthracoid maladies from other diseases which present somewhat similar symptoms, but require different treatment. With this object I am drawing up a paper of instruction for circulation.

15. *Surra.*—I have continued my study of the life history of the organism and have been re-writing, as far as circumstances have permitted, the third volume of my Surra report the manuscript of which was destroyed by the fire of 1899. I may mention that I have received several indents for the published volumes from Europe and the Colonies.

16. *Lymphangitis Epizootica* is a disease which suddenly broke out as an epidemic in 1899, and as reported last year, puzzled many Veterinary officers and others, and caused much destruction of remount animals. It was imported by mules from Italy and is often called "Neapolitan Farcy." I submitted a preliminary report last April, in which general information and instructions were given. I have since then continued my diagnosis of the disease by investigating specimens of pus supplied to me from different parts of India and have collected material for a second report on the etiology of the disease, in which the results of my further investigations will be given.

17. *Strangles* causes loss to the Remount Department and was therefore brought on to my list. The diagnosis of the disease itself requires little or no study as its characteristics are well known, but the determination of the organism causing the disease has not been satisfactorily effected.

III.—*The investigation of and progress made in preventive and curative remedies.*

18. *Rinderpest.*—A protective serum has now been worked out and two methods of preparation, one I call the "Slow" method occupying about 80 days, the other the "Rapid" about 14 to 20 days; by the latter method a serum can be produced in one-fourth of the time needed for the production of the former, while only a little of the quantity is required to bring about the necessary protection of the animal under experiment. The conclusion previously arrived at that hill cattle require much more powerful doses of protective serum than plains animals has been confirmed by experiment. For the benefit of those who may wish to learn the details of the methods, I shall submit a full report separately to the Director-General, Indian Medical Service. I have also devoted a great part of the time at my disposal, to researches which give every hope of working out preventives by means of methods which will make their manufacture in large quantities cheap, their distribution easy and their application simple.

19. *Anthrax.*—I have been developing a preventive serum which experiments have already indicated to be effective. A detailed account of my experiments and their results is under preparation and will be submitted in due course.

20. *Surra.*—I have worked out a serum which has been found to possess immunizing power, but difficulty has been experienced in preserving its destructive power for any length of time. My experiments will of course be continued.

21. *Lymphangitis Epizootica.*—Experiments conducted at Muktesar have shown that a cure can be effected by removing animals to a high level, 7,500ft. elevation, a result which agrees with the fact that the disease in Europe disappears above a given line of latitude. As the development of the disease occupies several months, the measure can easily and usefully be adopted in the case of valuable remount animals. I have also entered upon a series of investigations as to the life history of the organism with the view of working out a protective serum. I have meanwhile kept myself in constant communication on the subject with Remount and Veterinary Officers examining and reporting on all specimens of diseased material sent for my observation.

22. *Strangles.*—I have made investigation with which I am still proceeding with the object of discovering (*i*) the "materies morbi," (*ii*) a serum which will be destructive to it.

23. To enable me to select diseases for future investigation it would seem desirable that the valuable survey of diseases by the Veterinary Department temporarily interrupted should be gradually completed.

IV.—*The Central Institution and its functions.*

24. The chief functions of this institution during the past 12 months have been (*i*) to manufacture anti-rinderpest serum, (*ii*) to test such serum and issue it to officers on demand and (*iii*) to train Veterinary Assistants deputed here by the different District Boards (Punjab and N.-W. P.).

25. During the year 69,462 doses of anti-rinderpest serum were manufactured, and 24,232 doses distributed, as shown in Appendix I. The sanction

of Government has been received to purchase an oil engine and a second centrifugal machine, and it is hoped that the next year's output will be larger.

26. Before any anti-rinderpest serum is issued from this laboratory, it is carefully tested as to its protective power. For this purpose animals are procured from the hills, Kumaun Division, and plains from the Bareilly District. As some doubt existed as to the protective power of the serum forwarded to the Jullunder and Hoshiarpur districts in July last, I suggested that the Superintendents, Civil Veterinary Department, of each Province should obtain a certain number of each breed of cattle found in their districts, and submit them in turn to experiment, first by the simultaneous method, and second by the serum alone method, in order to ascertain the doses of anti-rinderpest serum required to protect such different breeds. Otherwise, a few selected animals of each breed might be conveyed to the Imperial Bacteriological Laboratory Depôt at Bareilly as opportunity offers, and there submitted to the above tests.

It must be remembered that in a vast continent like India, all breeds do not present the same degree of susceptibility to rinderpest as evidenced by the experience gained at Muktesar with regard to plains and hill animals.

From information received, it would appear that animals located on lands adjoining large rivers are more susceptible and suffer from a more virulent form of rinderpest than those which are situated at a distance from such water.

27. During the year, it was decided by Government to train Veterinary Assistants of different District Boards, etc., at this Laboratory, (1) in the general principles of serum therapeutics, especially with regard to rinderpest; (2) bleeding of animals for virulent blood; (3) defibrinating blood; (4) preservation of virulent blood; (5) practical sterilisation of instruments, etc.; (6) manipulation of Koch's syringe.

During December last, two Veterinary Assistants, Kotu Ram from Ferozepur District Board and Agha Ali from Ulwar State, reported their arrival, and have now passed through the course. Accommodation is now provided at Muktesar for the continuous reception of four Veterinary Assistants at a time and their course is fixed for three months. Theoretically they are taught the principles of different immunising (rinderpest) methods, in addition to the practical course laid down for them as mentioned above. When trained, these Veterinary Assistants are the men who at a later date we shall have to rely upon to perform the preventive inoculations in the field under the supervision of their respective Veterinary Superintendents.

28. *New Laboratory Buildings.*—The destruction of the Laboratory by fire is to be deplored, but a Phœnix has arisen from its ashes, and the new building is even superior to the old one, minor defects having been remedied. The Lieutenant-Governor of these Provinces, Sir Antony MacDonnell, has taken great interest in the restoration and the building, which will be in two or three months complete and ready for occupation.

29. The land surrounding the building has proved sufficiently adapted to the purposes for which it is required; and it is doubtful whether anywhere but in the hills such suitable conditions could be found. In the plains, on the other hand, the soil, air and water are at certain seasons liable to complicate experiments by infecting the test animals with other diseases, while surrounding cattle may communicate epidemics, *per contra*, the cattle inoculated on the Bacteriological estate must be isolated from private cattle.

The experience of this year during which laboratory experiments have been more continuously worked at than in any previous year, has proved that the Muktesar climate is sufficiently suitable for Bacteriological work and that my view that a high elevation in the Himalayas would be preferable to artificially cooled rooms in the plains has been justified. Having had experience at Poona, my conclusion may be of some service to the Medical Department when considering schemes for Bacteriological establishments.

V.—*The machinery now existing and required for work in the field.*

30. The necessity of such an agency is obvious. I have during the past year in connection with the Veterinary Department made arrangements for training a few members of the Civil Veterinary Staff. At the present time the

agency existing consists of Veterinary Assistants only, who cannot be depended upon to do the inoculation work independently until they have been specially trained at this Laboratory.

31. A Conference was held in Simla on the 17th September 1900, at which it was decided to institute depôts for the reception of immunizing agents in each Province. To maintain a stock of serum at any local centre, the Local Governments should arrange to get the supply from this Laboratory and start the inoculation work under the direct supervision of their Veterinary Superintendents, as long as the reputation of this curative agent is not thoroughly established.

32. The experiment to prove whether serum will keep indefinitely in any climate if kept under proper precautions is not yet finished. A certain quantity of it has been deposited in the Deputy Commissioner's office at Jacobabad, and will be sent for and tested when it has undergone an exposure to the highest temperature in that locality.

VI.—*Actual work done in the field.*

33. The inoculations in the field were conducted by the Superintendents of the Veterinary Department, but especially by the Assistant to the Inspector General, Civil Veterinary Department. The detailed results of these inoculations will be noticed by the officers of the Civil Veterinary Department in their respective annual reports. The following short abstracts, however, have been collated from the preliminary reports submitted to this office and are here placed on record.

34. With regard to results of inoculations in the Simla District, during the months of May and June last, the Inspector General, Civil Veterinary Department, remarks, "I might add that the results of the inoculations with serum alone in the affected dairy in Simla and at the affected stages of the Bullock Train Service between Simla and Solon, were eminently successful."

35. Results of further inoculations made in Hoshiarpur and Jullunder were not so satisfactory though I satisfied myself that the serum issued from the Laboratory was not in fault.

36. The Assistant to the Inspector General inoculated some cattle in the Dehra Dun District during the month of September by serum alone and the simultaneous method, and found the results satisfactory. The same officer reports that 485 inoculations carried out in the Hill States of the Simla District, Bushair and Jubal, gave extremely satisfactory results.

37. The Superintendent, Civil Veterinary Department, Bengal, caused the cattle of Ranigunge and Burdwan districts to be inoculated with the serum despatched from this Laboratory, and reports:—

"Rinderpest having broken out in Chittagong and Ranigunge, a sub-division of the district of Burdwan, two senior students were deputed to inoculate the healthy cattle by the plain anti-rinderpest serum method in both places. In Chittagong, 660 head of cattle were inoculated and in Ranigunge 366. In each case, the students revisited the villages some weeks after the inoculation had been completed, with a view of ascertaining the results. From the reports of the students, of which copies are enclosed, it appears that the results so far are encouraging. The death rate in both places appears to have been greatly checked, although statistics of this description are apt to contain errors."

(*ii*) With regard to inoculations in Calcutta Municipal Gowkhannas, the same officer remarks that 32 out of 769 inoculated animals developed rinderpest, of which 26 died and 6 recovered.

(*iii*) Regarding Kanti inoculations, he says: "Experiments with anti-rinderpest serum inoculations were also carried out at Kanti. Thirty-eight head of cattle died before inoculation. After the inoculation, 4 out of the 225 inoculated cattle were attacked, of which only one, which had developed the disease eight hours after the operation, died. The other three had it in a mild form. The results were considered to be very satisfactory."

38. Owing to the objection put forward by the natives of Bengal against the use of virulent blood, the method employed in the above outbreaks was "Serum alone," but unfortunately the doses of serum injected were inadequate for that method, in most instances the quantity of serum utilized was only sufficient for the "simultaneous method" when virulent blood is

injected at the same time as the serum but on opposite sides of the body, and a modified form of rinderpest produced.*

39. The Chief Commissariat Officer, Peshawar, reports that "on the 11th December 1900, rinderpest broke out amongst the slaughter cattle (cattle, 481 and sheep, 711) at Peshawar. From 11th to 25th December, 97 animals were destroyed or died. On the 22nd December a case of protective rinderpest serum was received from the Imperial Bacteriologist and the whole of the animals at the Jubba Jhil were inoculated on the 22nd, 23rd, 24th and 25th December 1900. From the 26th December 1900, to the 5th January 1901, thirteen animals died, after this date, the epidemic had actually ceased and no fresh cases occurred. The inoculation of the animals with the serum decidedly stopped the disease, as in addition to preventing the healthy animals from becoming affected, it also reduced the mortality amongst those that were already affected and the majority of which recovered. The benefit of the serum can also be seen in the death percentages both before and after the inoculation. Before inoculation 20·16 per cent., after inoculation 2·70 per cent.

"It was also due to the serum that the sheep, which were kept in the same locality, were not affected. Just before the inoculation, they were taken out and segregated as suspicious but when inoculated did not develop rinderpest."

40. The results have thus shown such pronounced success as to justify the prosecution of urgent measures for wide action.

41. In the case of Lymphangitis Epizootica, I have made three personal inspections of the animals segregated for my observation at Hapur. The main results were that I determined the extremely long period of incubation in equines, and the comparative, if not complete, immunity of bovines, etc.

A. LINGARD, M.B., M.S., D.PH., ETC.,

Imperial Bacteriologist.

27th May 1901.

APPENDIX I.

Table showing the amount of anti-rinderpest serum manufactured and despatched during the year 1900-1901.

Number of Serum.	Amount manufactured.	
	C. C.	Doses.
VII .	97,503	19,500
VIII .	160,000	32,000
IX .	89,809	17,962
Total .	347,312	69,462

Note.—In addition to the quantity of anti-rinderpest serum manufactured from the regular serum-producing animals, a further quantity is now in stock collected from the different animals under experiment. This latter serum, generally speaking, possesses a much higher protective value than the materials issued, and it will be tested in bulk and issued when required.

Issue.

Serial No.:	Date of issue.	To whom consigned.	Number of cubic centimetres.	Number of doses calculated for plains animals per 600 lbs. B. W. Serum Sim. method.	Quantity returned as unused.	
					C. C.	Doses.
1	21st April 1900 .	The Superintendent, Civil Veterinary Department, Bombay.	6,300	630	...	...
2	25th May 1900 .	The Assistant to the Inspector General, Civil Veterinary Department, Simla.	10,000	1,000	...	...
3	26th May 1900 .	The Senior Veterinary Officer, Umballa .	2,500	250	...	...
4	6th June 1900 .	The Assistant to the Inspector General, Civil Veterinary Department, Simla.	10,000	1,000	4,880	488
5	23rd June 1900 .	The Principal, Veterinary College, Bombay.	100	20	...	...
6	14th July 1900 .	Veterinary Major J. W. A. Morgan, Superintendent, Civil Veterinary Department, Bombay.	2,800	560	...	...
7	3rd August 1900 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	5,000	1,000	2,100	420
8	20th August 1900 .	The Superintendent, Civil Veterinary Department, Madras.	5,000	1,000	...	...
9	24th September 1900	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	10,000	2,000	2,700	540
10	25th October 1900 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	10,000	2,000	8,210	1,642
11	9th November 1900 .	The Superintendent, Civil Veterinary Department, Burma, Rangoon.	15,400	3,080	...	...
12	Ditto .	The Assistant to Inspector General, Civil Veterinary Department, Simla.	9,100	1,820	...	...
13	26th November 1900.	The Assistant to Inspector General, Civil Veterinary Department, Simla.	11,900	2,380	...	...
14	17th December 1900.	The Chief Commissariat Officer, Peshawar	7,700	1,540	...	...
15	10th January 1901 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	5,000	1,000	3,500	700
16	2nd March 1901 .	The Superintendent, Civil Veterinary Department, Bombay, Ahmednagar.	5,600	1,120	...	...
17	10th March 1901 .	F. J. Needham Esq., Political Officer, Sadiya, Assam.	10,000	2,000	...	...
18	3rd March 1901 .	Mr. A. T. Toomey, Kanti, Tirhoot .	3,000	600	...	...
19	15th March 1901 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	5,110	1,022	...	...
20	22nd March 1901 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	20,000	4,000	...	...
		Total .	154,510	28,022	21,390	3,790

APPENDIX II.

Table showing the number of the Locust Fungus tubes despatched from the Imperial Bacteriological Laboratory during 1900-1901.

Month and date of Despatch.	Name of person.	Name of Station.	Number of tubes.
10th May 1900	The Superintending Surgeon, Kashmir	Srinagar	6
19th May 1900	The Political Agent, Chagi	Quetta	6
24th May 1900	The Superintending Surgeon, Kashmir	Srinagar	4
7th June 1900	The Political Agent, South Beluchistan	Karachi	4
8th June 1900	The Assistant Political Agent, Thal-Chotiali	Duki	4
„	The Extra Assistant Commissioner, Duki	Duki	4
„	Do. do. Sibi	Sibi	4
„	The Political Agent, Thal-Chotiali	Ziarat	4
11th June 1900	Do. Quetta	Quetta	4
12th „	Do. Zhob	Zhob	5
29th „	The Deputy Commissioner, Bilaspur (Central Provinces)	Bilaspur	4
5th July 1900	The Political Agent, Kilat and Bolan	Quetta	6
7th September 1900	The Deputy Commissioner, Bilaspur, (Central Provinces)	Bilaspur	4
„	The Director of Land Records and Agriculture, Bengal	Calcutta	3
8th „	The Deputy Commissioner of Raipur	Raipur	6
19th „	Do. of Thar and Parkar (Sind)	Umarkot	4
25th October 1900	The Political Agent, Cutch	Bhuj	6
29th „	The Resident, Northern Rajputana States	Jodhpore	10
2nd November 1900	The Assistant Resident, Amreli, Kathiawar	Amreli	1
6th „	Raoji B. Patel, Esq., M.R.A.C.	Baroda	1
10th „	The Muktiyarkar, Thar and Parkar, Sind	Umarkot	6
18th December 1900	The Resident, Bikanir State	Bikanir	6
19th „	The Director of Land Records and Agriculture, Punjab	Lahore	6
11th February 1901	The Political Agent, Thal-Chotiali	Sibi	2
14th „	The Assistant Political Agent, Duki	Duki	8
16th „	The Director of Land Records and Agriculture, Punjab	Lahore	8
18th „	The Deputy Commissioner of Muzaffargarh	Muzaffargarh	2
„ „	Do. of Dera Ismail Khan	Dera Ismail Khan	2
21st „	The Assistant Political Agent, Duki	Duki	4
20th March 1901	The Political Officer, Kelat	Quetta	6
„	The Director of Land Records and Agriculture, Punjab	Lahore	12
25th „	The Political Agent, Quetta	Quetta	4
		Total	156

APPENDIX III.

Table showing the number of doses of English and French Mallein issued from the Imperial Bacteriological Laboratory during 1900-1901.

Serial No.	Date.	To whom issued.	Number of Doses.	
			English.	French.
1	22nd September 1900	The Superintendent, Civil Veterinary Department, South Punjab, Amritsar.	20	20
2	4th October 1900	The Superintendent, Civil Veterinary Department, North-Western Provinces, Babugarh.	5	5
3	18th „	The Principal, Bombay Veterinary College, Bombay	20	20
4	24th November 1900	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	40	40
5	26th December 1900	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	34	...
6	10th January 1901	The Superintendent, Civil Veterinary Department, North-Punjab, Rawalpindi.	...	20
7	30th „	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	50	...
8	5th March 1901	The Superintendent, Civil Veterinary Department, Madras, Chepauk.	...	20
		Total	169	125

G. I. C. P. O.—No. 195 R. & A.—4-9-1901—292—J. F. Fraser.

No. 3234—108-2.

FROM

R. E. V. ARBUTHNOT, ESQ., I.C.S.,
Under-Secretary to the Government of India,

To

THE DIRECTOR GENERAL,
INDIAN MEDICAL SERVICE.

Dept. of Rev. and Agri.
Civil Veterinary Administration.

Simla, the 23rd August 1901.

SIR,

WITH reference to your letter No. 3960, dated the 7th June last, I am directed to communicate the following orders on the report of the Imperial Bacteriologist for the year 1900-1901.

2. The Imperial Bacteriologist and his staff were mainly occupied during the year in the manufacture and testing of rinderpest serum. The Government of India notice with satisfaction the good work done in this direction and the increasing demand for the serum of which 69,462 doses were made and 24,232 doses distributed. They desire to lay stress upon the importance of further experiment to ascertain the strength of the doses required by the different breeds of cattle. Experiments with this object obviously cannot be effected by the collection of animals at the Bareilly depôt from all parts of India, and Dr. Lingard should, as suggested in paragraph 26 of the report, seek the assistance of the provincial Superintendents of the Civil Veterinary Department who should locally test the value of the serum. He should also, if possible, arrange to experiment himself in the provinces, making tours for the purpose.

3. With reference to paragraphs 14, 16, 19 and 20 of the report the Government of India will be glad to receive copies of the instructions and reports in connection with anthrax, Lymphangitis Epizootica, Anthrax serum and Surra serum.

4. The subject of paragraph 27 of the report, *viz.*, the training of Veterinary Assistants in the principles of serum therapeutics has been under separate consideration by the Government of India and a separate communication will be made to you regarding it. It is contemplated to extend the arrangements for training of inoculators. The class at Muktesar will include 8 men and during the cold weather as many as 20 men will, it is hoped, be kept under training at the Bareilly depôt.

5. The report has been much improved in arrangement and conciseness, but I am to request that in future the subjects with which it deals may be classed in three sections dealing respectively with (1) Research, (2) Application of the results of Research, and (3) Administration.

I have the honour to be,

SIR,

Your most obedient Servant,

(Sd.) R. E. V. ARBUTHNOT,
Under-Secretary to the Government of India.

F.1142 30
2

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1901-1902.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1902.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1901-1902.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1902.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1901-1902.

SECTION I.

Research.

Rinderpest.—In addition to the chief work of preparing 50,000 doses of anti-rinderpest serum as ordered by Government, experiments have been continued during the year under review with the object of determining the best method of producing a serum, in the shortest possible time and possessing the highest protective value. For this purpose, the following kinds of animals were utilized: *viz.*, plains cattle, hill cattle and buffaloes.

2. Serum was prepared by the slow and rapid methods, and various modifications of detail have been introduced and worked out in order to further the objects of this research. To arrive at a definite conclusion with the above object in view, experiments were necessary and have been carried out with each kind of material manufactured. These researches have entailed the use of a considerable number of susceptible animals, *viz.*, hill cattle.

3. As regards the results of these experiments, in addition to other researches, which have been continuously worked at during a period of the last 2½ years, I hope to be in a position to submit a full and detailed report to Government within the next few months, should I be able to find the necessary leisure to cope with the mass of material now in hand. Amongst several of the most useful results which have been arrived at, and which are of general importance in the manufacture of anti-rinderpest serum, I may mention the following.

(i) Animals (bovines) under three years of age should not be utilized for the purpose of serum preparation, as they yield a serum the protective power of which may be 5 to 8 times less than that yielded by the same breed of animal above three years of age.

(ii) In the preparation of serum, the rapid method allows of its being prepared and ready for use, within a period of 21 days from the first injection of the protective material, whereas, by the so-called slow method, 80 days were required before serum could be obtained.

(iii) By the rapid method, large doses of virulent blood, injected into the serum animal, do not yield proportionate results in producing a high protective serum. For, it has been found that if doses over 6,000 to 7,000 c.c. are injected at one time, a weak or attenuated form of serum is the result.

4. Experiments have been undertaken to prove whether sera will retain their initial protective power in the plains, when exposed to the maximum shade temperature in the respective localities in which depôts for the reception of sera have to be selected. Sera of known protective power previously tested upon the most susceptible breed of cattle, were deposited for varying periods in Jacobabad, Madras and Rangoon. The following is a short resumé of the results ascertained.

5. *Jacobabad.*—Two sera, *viz.*, Nos. VII and VIII, were deposited in the office of the Collector of Jacobabad on the 17th January and retained there until the end of July 1901. During this interval, the following maximum shade temperature readings were recorded :—January 78·4° F., February 89·5°F., March 107·4°F., April 112·2°F., May 123°F., June 125°F., July 126°F. On being returned to Muktesar and retested, No. VII was found to have lost 40 per cent. in protective power, *i.e.*, a hill animal required a dose of 150 c. c. in order to bring about protection by the Simultaneous method" instead of 90c. c. per 600 lbs. as standardized at the time of issue. No. VIII serum, on being re-tested at Muktesar, was found to have lost 66·6 per cent. in protective power, *i.e.*, a hill animal required a dose of 270 c. c. in order to bring about protection by the Simultaneous method, instead of 90 c. c. as standardized at the time of issue.

6. *Madras.*—No. VII serum was forwarded to the Superintendent, Civil Veterinary Department, Madras, on the 20th August 1900, and after using a certain quantity, the remainder was deposited in the above gentleman's office until 18th November 1901, when at my request it was again despatched to Muktesar for the purpose of re-testing. No. VII serum was standardized for hill cattle at Muktesar at 90 c. c. per 600 lbs. body weight, and during its deposition in Madras was exposed to a maximum temperature of 108·5°F. in June 1901, during which month the highest annual thermometric readings are recorded. On re-testing at Muktesar on hill cattle, it was found that instead of 90 c. c. being required to protect this susceptible breed of animals, 200 c. c. per 600lbs. were necessary. It will, therefore, be observed that this sample of serum (No. VII) had lost 55 per cent. in protective power.

7. *Burma.*—Nos. VII and VIII sera were forwarded to the Superintendent, Burma, on 9th November 1900, and were retained in that gentleman's office until the time of his respective inoculations during April to November 1901, a period of 6 to 12 months. During this interval the maximum temperature of the year, 104°F., was registered in April, the hottest month in Burma. It will be seen by that officer's report, paragraph 31, that " he was equally successful with the Simultaneous method," after injecting the laboratory standard doses. For this reason, the serum which had been exposed to a maximum temperature of 104·1°F. did not appear to have lost in protective power, but it must be noted that these experiments by the Simultaneous method were carried out in plains cattle in Burma, and not on the highly susceptible breed of hill cattle utilized at Muktesar, which can only be protected by the injection of 18 times the doses necessary for plains animals.

8. From the above recorded experiments, it will be seen that samples of sera Nos. VII and VIII, deposited in Jacobabad, and exposed to a temperature rising to 126° F., lost in protective power respectively to the extent of 40 and 66·6 per cent. in comparison with the standardized dose registered when issued. In Madras, a sample of No. VII serum was found to have lost in protective power to the extent of 55 per cent. when exposed to a temperature rising to 108·5°F. While in Burma, samples of the same sera (Nos. VII and VIII) were tested by Veterinary Captain Evans, after being exposed to a rising temperature of 104'1°F., and were found to have retained their protective power when utilized by the Simultaneous method," equally as when used by the serum alone method. In the latter instance, however, it must be noted that a sample of the Burma serum, after exposure, had not been re-tested at the Laboratory on hill cattle, and that all Veterinary Captain Evans' experiments were carried out on plains animals, which in many instances possess a more or less degree of immunity, either hereditary or acquired, so that $\frac{1}{18}$th of the dose of protective serum required by hill is sufficient to bring about the necessary immunity in plains cattle. It must be stated that at Muktesar the sera kept for long periods through hot and cold seasons, do not deteriorate in their protective value, and it is a well-known fact that the specific action of normal and of bactericidal sera is entirely lost, if allowed to stand or warmed to 55° C., or 131° F. Consequently, from the above experiments, it will be apparent that the protective power of the above sera has been materially diminished after exposure to a much lower temperature than 131°F., *viz.*, to 108·5°F.

9. *Cawnpore, Poona and Nagpore experiments.*—In accordance with the orders of the Government of India conveyed in their letter No. 4070—186-2, dated 4th December 1901, arrangements were made to carry out experiments in Cawnpore (United Provinces), Nagpore (Central Provinces) and Poona (Bombay), with a view to ascertain the strength of the doses of anti-rinderpest serum prepared at Muktesar, which may be most economically used in order to protect the various breeds of plains cattle. After settling the details of work required to be done in each Province with the respective Director of Land Records and Agriculture, I proceeded first to Cawnpore on the 11th January 1902. A full and detailed report of the results of these experiments was forwarded to Government on 29th April 1902, together with temperature charts of the respective animals and an album containing photographs of nearly all cattle and sheep utilized during such experiments.

10. It will be interesting to note the results obtained in the cattle of the respective Provinces visited.

Cawnpore.—As far as the results of the observations at Cawnpore go, and taking into consideration the ages of the animals experimented upon, it would appear that all possess a considerable amount of hereditary immunity against rinderpest; the exact amount, however, it would be impossible to calculate, for none of the Control animals succumbed to the disease. For practical purposes, it may be concluded that 10 c. c. of anti-rinderpest serum, equal in protective value to that of No. XI, administered by the "Serum alone" method, would, in an ordinary outbreak, be sufficient to ward off the effects of the disease.

11.—*Poona.* (*a*) *Sindh breed.*—It appears from the results of experiments that 8 c. c. of anti-rinderpest serum would prove ample to protect this breed of animal by the "Simultaneous method." In the event of an outbreak of rinderpest, 15 to 20 c. c. by the "Serum alone" method should prove sufficient to pass them through an outbreak of disease lasting several months.

(*b*) *Aden breed.*—This breed of cattle was found most susceptible to rinderpest, probably on account of the isolated position of Aden and the infrequency of the visitation of cattle disease to that portion of Arabia. It, therefore, requires a much larger dose of anti-rinderpest serum than that administered to plains animals. Until careful experiments can be conducted with a view to determine the exact dose necessary, it would be advisable to give them the benefit of the doubt and treat as Himalayan, with eighteen times the quantity necessary for plains breeds.

(*c*) Of the other breeds of cattle including, two *Deccani* (inoculated with 7 and 9 c. c. per 600lbs.), one *Khilar* (10 c. c.) and one *half-bred Surti* (9 c. c.), the latter only showed symptoms at all, and those of a mild form. The number of animals submitted to experiment were too small to draw any definite conclusion from, but one may safely surmise that 6 c. c. for Deccani and 8 to 10 c. c. for each of the other two breeds would more than suffice.

(*d*) *Buffaloes.*—Six buffaloes were tested with anti-rinderpest serum, five being of Gujrat and one Jafferabad breed, three received 5 c. c., one 6 c. c. and two 7 c. c. (per 600lbs.) each. One buffalo with 5 c. c. per 600lbs. body weight showed well marked symptoms, but all recovered. The experiments with these breeds show that a dose of 7 c. c. would be sufficient to protect by the "Simultaneous method". Therefore 20 c. c. of No. XI serum, by the "Serum alone" method, would give sufficient protection to guard against rinderpest during three to four months.

12. *Nagpore.*—In order to derive any definite conclusion from the experiments carried out at Nagpore with animals crossed and re-crossed with different breeds of cattle, it would be first necessary to have definite results before one as to the way in which the individual breeds, of which they are composed, react to the serum test. But as this is next to impossible to carry out, we can only fix the dose for the mixed breeds as commonly met with in the open market. As regards the results of Nagpur experiments, I would point out that in the mixed breeds 7 c.c. (of No. XI serum) per 600 lbs. body weight appears to be sufficient to bring about protection by the "Simultaneous method"; for, although several of the animals presented symptoms of rinderpest after inoculation with varying quantities of anti-rinderpest serum, nevertheless, of the five control animals which received doses of virulent blood alone, varying from 3 to 10 c.c., none succumbed to rinderpest. Consequently, from 15 to

20 c.c., of anti-rinderpest serum will be ample to give protection by the "Serum alone" method for a period of several months.

13. *Anthrax.*—The opinions expressed by me in the concluding portion of my letter No. 526, dated the 29th August 1900, with regard to the preparation of a serum for Anthrax and Anthracoid diseases, were approved of by the Viceroy in Council, as referred to in Government of India, Revenue and Agricultural Department, No. 54 of 1900, dated 4th October 1900, to Her Majesty's Secretary of State for India. Consequently, during 1900-1901, experiments were taken in hand with a view to the preparation of a protective serum against Anthrax, which has been further developed and brought to a successful issue during the year under review.

14. The mode of procedure adopted for the purpose of immunising animals was similar to that utilized in the case of rinderpest, except that enormous quantities of Anthrax material had to be prepared in bouillon and cultivated in the incubator for several days and later injected subcutaneously, instead of the injection of virulent blood as in rinderpest. The other details with regard to repeated injections at intervals, are somewhat similar to those used in the preparation of anti-rinderpest serum.

15. From the date on which the initial experiments for the purpose of protecting the selected animal against Anthrax, to the date of the first bleeding, for the purpose of collecting the serum, a period of from four to five months must elapse, and even then only one bleeding can be effected, and another injection of virulent anthrax cultivation has to be made in order that a subsequent bleeding may follow. As the experiments progress, it is hoped that a shorter period will be required to produce a more highly efficient serum.

16. In the preparation of a protective Anthrax serum, plains and hill cattle, and in addition buffaloes have been utilized for the purpose. Our researches have elucidated the following important facts amongst others:—

(*i*) The inoculated disease in this country runs a course in plains animals of from 70 to 144 hours, and in hill cattle from 35 to 120 hours.

(*ii*) The hill breed of cattle, as in the case of rinderpest, is much more susceptible to Anthrax than the plains, and it has been observed that a weak culture of the Bacillus Anthracis, which had no effect on several plains animals, readily brought about a fatal result in the more susceptible breed, *viz.*, Himalayan cattle, as well as in equines, sheep and goats.

(*iii*) With regard to the protective power exercised by the anti-anthrax serum manufactured up to the present, it has been proved that plains animals, of about 300 to 400 lbs. and over two years of age, require a dose of 10 c.c., whilst the hill breed of animals, 150 to 200 lbs. in body weight, require a dose of 50 c.c., that is, the small Himalayan cattle must receive at least five times the dose given to plains breeds.

(*iv*) It is a point of great importance, however, to remember that young cattle under two years of age, require a much larger dose of this protective serum than adult animals of the same species.

17. *Lymphangitis Epizootica.*—During the year under review, 134 specimens of tissues and pus taken from suspected animals were received at the Laboratory from different localities dotted over India, for examination and report. Of the total number of specimens, 70, or 52 per cent., were found to contain the Cryptococcus of Lymphangitis Epizootica, and in 64, or 47·8 per cent., the organism was absent.

18. Through the courtesy of the Director, Army Remount Department, I was enabled, on 25th March 1900, to initiate a number of comparative experiments in equines, bovines, buffaloes, sheep and goats, with a view to determine to what extent these animals were susceptible to Lymphangitis Epizootica when subcutaneously inoculated with fresh material just collected from a recent case. On the 27th March 1902, after a period of over two years, and at the request of the Director, Army Remount Department, I determined to destroy the experimental animals in order to find out whether any of them had lesions in their internal organs. A few weeks after the primary inoculation of the Lymphangitis Epizootica material containing the Cryptococcus,

considerable lesions were noted in the horses and mules, and ones of a slighter character, beneath the skin at or around the seat of inoculation, in the bovines; the "materies morbi" of this disease being frequently recognised by the microscope in the affected tissues. After an interval of 1 year and 9 months, at which date the animals were destroyed and the *post-mortems* conducted, no trace of the inoculated disease could be found and no lesions of the internal organs referable to the same were observed.

19. In conjunction with Veterinary Captain Cranford, Army Veterinary Department, experiments were undertaken to ascertain whether horses could contract the above mentioned disease, when "mutty" obtained from the standings of diseased animals was applied to the surface of granulating wounds. Three animals (equines) were used for these experiments:

In the first experiment, the "mutty" was taken from the just vacated standing of a bad case of Lymphangitis Epizootica, and the result was positive. In the second and third, certain selected standings, previously occupied by severe cases of the above disease, were railed in and allowed to be exposed to the weather, during a period of two months, before the material was collected and smeared on the granulating surfaces. The granulating wounds were cleaned and smeared daily with "mutty" obtained from the above source, between 30th July and 7th September 1901. Although the second and third cases remained under daily observation for a period of eight months, no untoward symptoms resulted and no Lymphangitis Epizootica supervened.

20. Lymphangitis Epizootica has now become a generalized disease in many districts in India. On investigating the outbreaks at Hapur and Karnal Remount Depôts in 1900, affecting horses and mules, I traced the disease to previous cases imported from Italy, but in no way connected one with the other. During my visit to Hapur, 27th March 1902, I found two animals segregated in the confines of the depôt, only received from Lahore and Jacobabad fairs within a period of three weeks, the former to be suffering with well marked Lymphangitis Epizootica, in the tissues of which the Cryptococcus was demonstrated microscopically, and the latter presented every symptom of an early case.

21. *Surra.*—Researches with regard to this absolutely fatal disease in equines, has been continued during the year under review. There is not much to note with the exception that a serum was prepared which possessed a power of destroying "in vitrio" the Trypanosoma of Surra in two and-a-half minutes, and the Trypanosoma in control specimens still survived after a period of 6 or 7 hours. Even in equines suffering from Surra, subcutaneously and intravenously injected with this strong serum, the tendency was always for the Trypanosoma to return after an interval of days, and the serum was therefore of but very little value. From such serum, it is feared, no hope of success can be entertained, and for this reason modifications will have to be introduced and other lines of research entered upon, especially when the Bareilly Depôt is complete and work commences there.

22. *Strangles.*—Whenever the opportunity has been afforded of obtaining material from animals in the plains affected with this disease, cultivations have been secured and forwarded to the Laboratory for further investigation, but up to the present, I have been unable to reproduce this disease in equines, at an elevation of 7,500 feet, from cultivations grown at Muktesar. Consequently, but little progress could be made in the preparation of a serum capable of combating this affection.

23. During this year, I have seen and secured photographs of animals affected with Lymphangitis Epizootica and Strangles at the same time, rendering an absolute diagnosis impossible without the aid of the microscope, but when this instrument was used, the organisms of the two diseases were easily recognised.

24. *Paralysis.*—On the Director, Army Remount Department, wiring concerning severe outbreak of Paralysis affecting equines at Karnal Remount Depôt, I was ordered, by the Secretary to Government, Revenue and Agricultural Department telegram No. 4047, to proceed to Karnal immediately. On arrival, every endeavour was made to determine the cause of the outbreak principally amongst Australian remounts. The disease was observed to follow

three different courses, *i.e.*, an acute, semi-acute and a chronic form. Most of our investigations were confined to the two latter, as the cases of the former were uncommon. Twenty-two autopsies were conducted, and experimental inoculations performed on equines, bovines, sheep and goats. Further, investigations were made with regard to the water and fodder supply, and the services of the Superintendent, Saharanpur Botanical Garden, were requisitioned as to the different diseases of the fodder crops, and complete specimens of the latter were forwarded to the Cryptogamic Botanist to the Government of India for examination and report. Much new light has been thrown on the causation of this disease, but as the question is of a most abstruse character, much close attention and observation is required to solve the problem, which will be continued as opportunity offers. The Director, Army Remount Department, has been requested to initiate certain experiments this season, at Karnal, in order to elucidate whether the well water is at fault.

25. *Influenza.*—During my sojourn at Poona, while conducting serum test experiments during March 1902, I was asked by the Director, Army Remount Department, to visit Ahmednagar Depôt on my way to Nagpur, with a view to observe and conduct any possible researches into the causation, etc., of Influenza. This affection yearly attacks the new remounts arriving in this country, and although fatal in a small number of cases, nevertheless, it is the cause of reducing the strength of the young stock to such a degree that it not only renders them extremely susceptible to contract other maladies, but at the same time retards their progress and evidently is a source of great loss to Government. Although at the time of my visit to Nagpur, most of the depôt animals had recovered, a second severe outbreak occurred, on the day previous to my arrival, amongst the horses of the 79th Field Battery quartered there, and through the kindness of Veterinary Lieutenants Hunt and Bolton, Army Veterinary Department, I was enabled to observe a large number of affected animals and to conduct two autopsies and collect the necessary pathological material for making further investigations at the Laboratory.

Section II.

Application of the results of research.

26. *Rinderpest.*—During the past twelve months, 392,246c.c. of anti-rinderpest serum have been prepared, and 339,000 c. c, or 47,773 doses were issued, the details of which are shown in Appendix I. The serum prepared consists of 255,939 c.c. of tested serum, equivalent to 38,557 doses by the Simultaneous method, and a further quantity of 136,307 c.c. up to the present untested, but which for the sake of convenience of reference may be deemed as equivalent to about 13,630 doses, taking it to be 10 c.c. standard per 600 lbs. body weight. The quantity 13,191 c.c. shown as "utilized in Experiments at Muktesar," for the purposes of testing the protective values of the different sera prepared, will, when once the results are fully worked out, not be a recurrent debit, but be added to the general serum manufactured for issue.

27. The Government of India has approved the scheme for greatly increasing the output of anti-rinderpest serum, in addition to that for Anthrax and other protective sera. Under the above-mentioned scheme, it is proposed to prepare a minimum of 100,000 doses of anti-rinderpest serum, and for this purpose the necessary accommodation for cattle, etc., and the machinery has been sanctioned, and arrangements are being made to carry out the required additions and alterations with utmost despatch, with a view to facilitate the increased output of the sera as much as possible, during the present official year 1902-1903.

28. The detailed results of the inoculations carried out by different officers to whom the serum was despatched, as noted in Appendix I, will be noticed in their respective Annual Reports.

29. The following results have been collated from reports received at this office concerning the work accomplished by the Superintendents, Bengal and Burma, with regard to the Serum Alone and Simultaneous methods of inoculation carried out in the field.

Serum Alone Method.

Province.	District.	Number of villages of which cattle inoculated.	Number of cattle inoculated.	Date or period of inoculation.	Number of inoculated cattle died.	Remarks.
Bengal	Purnea	2	389	May 1901	*Nil.*	
Do (Assam)	Sylhet	3	134	June 1901	1	
Bengal	Khulna	5	365	Do.	1	The villagers expressed an opinion that they had been greatly benefitted by the new method of treatment.
,,	Birbhum	4	302	August 1901	1	Most of the villagers gladly allowed their cattle to be immunised and were much satisfied with the result.
,,	Khulna	1	489	During the quarter ending November 1901.	3	
,,	Angul	7	420		1	
,,	Champaran	12	843		4	
,,	24-Parganas	5	850		8	
,,	Cooch Behar	3	37		*Nil.*	
,,	Birbhoom	3	550	...	*Nil.*	
,,	Champaran (Choterwa Factory.)	1	112	7th December 1901	*Nil.*	
,,	Backerganj	13	448	13th November to 10th December 1901.	1	
	Total		4,939		20	
			Serum Alone Method.			
Burma	Hanthawaddy	2	26	April to November 1901.	*Nil.*	
,,	Pegu	27	1,786		28	"Disease was severe and most animals had been exposed to contagion or were diseased."
,,	Magwe	1	200		*Nil.*	
	Total		2,012		28	
			Simultaneous Method.			
Burma	Hanthawaddy	1	57	April to November 1901.	3	"The deaths were due to rinderpest, no doubt contracted by exposure to contagion just prior to inoculation.
,,	Pegu	1	66		*Nil.*	
	Total		123		3	

30. On reference to the above table, it may be observed that out of 4,939 head of cattle treated by the "Serum alone" method in Bengal, 20, or 0·4 per cent., succumbed to rinderpest, and of 2,012 animals so treated in Burma, 28 deaths occurred. I may mention that these casualities in Bengal and Burma were not in any way referable to the method utilized; the animals which succumbed must in every case have had the disease germs in their system previous to the injection of serum, as mentioned by Veterinary Captain Evans in his remarks.

31. I trust that it may not be out of place to mention the following remarks communicated to me privately by Veterinary Captain G. H. Evans. It shows that when an officer himself carries out the serum injections among a rural population, at first averse to new protective methods, a large number of cattle will be brought forward to be similarly treated, when the confidence of the natives has been once gained by that officer.

"I have faithfully carried out your instructions in all matters pertaining to the subject, have inoculated animals of all sizes, ages, condition and colour, and you will, I hope, be pleased to hear without (as far as I have been able to

ascertain and I have spared no pains) an accident of any kind whatsoever, not even a swelling, certainly no ulcers. All Burmans were asked *as a favour* to report anything to me personally or to Township Officers, but no reports or complaints were received. I was equally successful with the "Simultaneous method;" only the people did not willingly accept it. The serum was excellent, clear, free from flocculi, etc. I used Nos. VII and VIII, and every bottle was good. ... I do not know anything of what has been done in India, but though I say so, the results with regard to the operation at any rate cannot be better. The serum was efficient in checking outbreaks. I think I can now get several thousand, in fact I have been promised them on condition I come out and do the inoculation or supervise the same. All my inoculations were carried out in the field under conditions such as the Assistants will have to do."

32. As regards the application of the researches carried out with a view to determine whether the samples of sera Nos. VII and VIII deposited, respectively, in Jacobabad, Madras and Rangoon, have in any way deteriorated in protective value, when exposed to the maximum shade temperatures recorded at each of the above-mentioned stations, I may here mention that serum deposited at depôts in the plains will materially lose in protective power, if allowed to be exposed to the ordinarily recorded maximum shade temperatures.

33. During the month of January last, 40,000 c. c. of anti-rinderpest serum was deposited equally at four depôts in the plains, *viz.*, Lahore, Calcutta, Ajmere and Ahmednagar. The following table shows the maximum shade temperature recorded at each station during the past two years, 1900 and 1901.

Years.	Ahmednagar.	Calcutta.	Lahore.	Ajmere.	Madras.	Rangoon.
	°F	°F	°F	°F	°F	°F
1900	106·4	103·4	118·6	114·4	110·0	105·1
1901	108·0	108·2	118·1	114·4	108·5	104·1

According to the results of Jacobabad experiments, it would appear that Lahore and Ajmere, respectively, with temperatures of 118·6 and 114·4 °F. are two of the worst possible stations for storing sera of any kind, but the other stations with their recorded high temperatures are in no way more suitable when compared with the Madras results. It is, therefore, imperative that if depôts are to be maintained in the plains where sera may be stored, suitable receptacles (Refrigerators) must be provided for the purpose and be supplied daily with sufficient ice during the months when the thermometer records 90° and upwards.

34. *Anthrax.*—The total amount of anti-anthrax serum manufactured during the year was 11,891 c c., of which 5,117 c c. were distributed as shown in Appendix II.

35. With regard to the result of serum inoculation, the Superintendent of Government Cattle Farm, Hissar, writes:—

"The result of the inoculation has been most satisfactory, as, although the animals have been and are in the portion of the Bir where the disease broke out, they have remained healthy." On the 28th August 1901, the above-mentioned officer inoculated 31 animals with serum 20 c. c. per 600 lbs., and on the 2nd September 1901, 28 animals were inoculated with 10 c c. per 400 lbs. body weight. "One animal out of the last inoculated was found dead the following morning; the autopsy revealed Anthrax. This animal to all appearances was healthy when inoculated." The last-mentioned animal must have contracted the disease four to five days previous to the injection of the serum.

36. The results of inoculations carried out by other officers are not forthcoming, and will most probably be noted in their respective reports.

37. *Other diseases.*—The chief diseases under observation during 1901-1902 were Rinderpest and Anthrax, but during tours in the plains, whenever opportunities occurred, other diseases mentioned in Section I were investigated, as far as time would allow of, in order that in due course observations may

accumulate, and when necessary be at our disposal to make use of. At present, it is somewhat difficult to record the various applications of the results of the researches undertaken, for none of these latter investigations are completely worked out, but are in various stages of development towards completion, and these results will be recorded in due course.

Section III.

Administration.

38. I remained in charge of the Laboratory during the year under review, and Veterinary Lieutenant J. D. E. Holmes, Civil Veterinary Department, took over the post of Assistant Bacteriologist from Veterinary Lieutenant G. K. Walker on 26th September 1901.

39. The major portion of the officers' time was occupied in preparing anti-Rinderpest and Anthrax sera and despatching the same to the Superintendents of the Civil Veterinary Department and other officers who applied for it. In addition, Test Experiments were continued throughout the year with a view to determine the protective power of the sera prepared. During the last three months of the official year, under the orders of Government, I carried out serum testing experiments in Cawnpore, Poona and Nagpur.

40. *Locust Disease Fungus.*—The results of the experiments recorded in last year's Annual Report were unaccompanied by any hope of ultimate success by the use of the Locust Fungus. But as no orders to the contrary were received from Government, demands for such cultivations were complied with. In all. 245 tubes were despatched to various stations throughout India, as detailed in Appendix III. The following are the brief abstracts of the reports received in this office :—

(*i*) The Dewan of Bikanir State reports that with the Locust Fungus tubes supplied by the Imperial Bacteriologist for experimental purposes in the State, the experiments were tried in three different Tahsils but without any successful result.

(*ii*) Deputy Commissioner, Bilaspur, Central Provinces tried it on grasshoppers, but no satisfactory results were obtained.

41. *Mallein.*—During the past twelve months, 332 doses of English and French Mallein have been distributed to the Superintendents of the Civil Veterinary Department, as shown in Appendix IV. The above number includes 100 doses of English Mallein despatched to the Officer Commanding the British troops at Shanghai, and 125 of French sent to the Superintendent, Hapur Remount Depôt, as directed by the orders of Government.

42. *Bareilly Branch Depôt.*—On account of unavoidable delay, the construction of the main Laboratory building and other necessary out-houses, was not taken in hand until the end of December 1901. On inspecting the progress of construction with the Engineer in charge on the 31st March 1902, I found that considerable progress had taken place since my last visit in January and the main building was being roofed. As the centrifuge and oil engine have been sanctioned by Government in addition to the chemicals and apparatus required, it is hoped that a start will be possible during the ensuing cold weather.

43. *Fodder-supply.*—Owing to the amount of work carried on at Muktesar during the past year, including the large number of serum test experiments, some difficulty was experienced with regard to fodder. During the present year, consequent on the increase in the number of cattle to be utilized, the demand will be still greater, and for this reason it became imperative to request the Local Government to extend the Laboratory boundaries, the necessary orders for which have recently been issued in the Government Gazette (dated 10th May 1902). The present Laboratory estate, now measuring 2,416 acres, will be increased by about 800 acres. It is hoped that as Government has now sanctioned the appointment of a farm overseer, greater facility will be found in obtaining the increased amount of fodder from areas to be placed under cultivation, nursery garden, and from the neighbouring forests up to a radius of 8 to 10 miles from Muktesar.

44. *Forest.*—The arrangements for carrying out the prescriptions of the working plan of Muktesar Reserve have proved satisfactory, and the forest has been successfully protected against fire. During the past rains, several nurseries were made and seeds (Deodar, Chir, Kail and Gum) sown in order to provide plants for filling up open spaces and for replacing the trees utilized during the year.

45. *Meteorological Observations.*—The collection and record of these observations have been continued three times daily. A copy of these has been regularly supplied to the Meteorological Reporter to the Government of India on the last day of each month. As the chief work of the Laboratory progresses, the wisdom of initiating these meteorological observations become more and more apparent, for reference has continually been made to the records of former years when tabulating results of experiments during various temperatures and when arranging for new researches.

46. *Buildings.*—It was hoped that the main Laboratory building, which at the time of writing last year's annual report was nearly complete, would have been ready for occupation during the cold season. Most of the rooms in the building, however, are not yet in a condition for occupation, owing to the want of funds for fittings and furniture, although the office and store-rooms have been made use of for the past few months.

47. *Training of Veterinary Assistants.*—During the year, fifty-five (55) Veterinary Assistants and Graduates were trained at Muktesar in the general principles of serum therapeutics, especially with regard to Rinderpest. The course in each instance lasted for a period of one month, and during this interval the students were instructed in the practical methods of inoculation, manipulation of syringes and other necessary instruments, but especial attention was paid to inculcate all details connected with the injection of animals in the field by the "Serum alone" method. Table No. XIX—Imperial—shows the detailed number of Veterinary Assistants deputed from each Province and Native State.

48. *Staff and Establishment.*—It is again most satisfactory to place on record the hearty co-operation I have received from the staff and establishment, which, as in previous years, has entailed continuous work on Sundays and leave days.

ALFRED LINGARD, M.B., M.S., D.P.H., etc.,

The 27th May 1902. *Imperial Bacteriologist.*

APPENDIX I.

Table showing the amount of Anti-Rinderpest Serum manufactured and despatched during the year 1901-1902.

Amount manufactured.		Amount issued.		Remarks.
Stock.	c. c.	Abstract of issue.	c. c.	
Balance in hand from 1900-1901.	214,192	Issued as per detail below . . .	339,000	
Manufactured during 1901-1902.	392,246*	Utilized in experiments at Muktesar .	13,191	
		Ditto ditto, Cawnpore, Poona and Nagpore.	2,400	
		Tested serum in hand	115,540	Equivalent to 23,108 doses.
		Untested ditto	51,895	
		Retained in small bottles for test experiments and standardizing serum.	84,412	
Total .	606,438	Total .	606,438	

* This consists of 255,939 c. c. or 38,557 doses (by simultaneous method) tested serum and the balance 136,307 c. c. untested.

Issue.

Serial No.	Date of issue.	To whom consigned.	No. of cubic centimetres.	No. of doses calculated for plains animals per 600 lbs. Body weight by simultaneous method.	Laboratory No. of serum.	Standard.
						c. c.
1	26th May 1901 .	The Superintendent, Civil Veterinary Department, Bengal.	15,050	3,010	VIII	
2	Ditto .	The Superintendent, Civil Veterinary Department, Bengal (addressed to Veterinary Assistant, c/o Magistrate, Khulna).	5,250	1,050	„	5
3	31st May 1901	Chief Commissariat Officer, Peshawar	4,200	840	„	5
4	10th June 1901 .	The Deputy Commissioner, Almora .	4,200	840	„	5
5	Ditto .	The Political Agent, Bhopawar, Mhow	4,200	840	„	5
6	13th June 1901 .	The Superintendent, Civil Veterinary Department, Bengal.	20,300	4,060	„	5
7	15th ditto .	The Superintendent, Civil Veterinary Department, Bengal (addressed to Magistrate, Khulna).	14,000	2,800	„	5
8	19th ditto .	The Superintendent, Civil Veterinary Department, Bengal (addressed to Veterinary Assistant, c/o Deputy Commissioner, Angul).	10,000	2,000	„	5
9	2nd July 1901 .	The Senior Veterinary Officer, Rawalpindi.	700	140	„	5
10	4th ditto .	The Superintendent, Zoological Garden, Alipore.	700	140	„	5
11	31st August 1901 .	The Superintendent, Civil Veterinary Department, Bengal.	25,200	2,520	IX	10
12	4th September 1901	The Chief Commissariat Officer, Peshawar.	1,400	280	VIII	5
13	8th ditto .	The Superintendent, Civil Veterinary Department, Bengal.	54,900	5,490	IX	10
14	3rd October 1901 .	Mr. B. Basu, Veterinary Graduate, Assam.	18,500	3,700	VIII	5
15	18th ditto .	The Superintendent, Civil Veterinary Department, Bengal.	40,000	5,000	X	8
16	21st ditto .	The Municipal Officer, Aden . .	700	87	„	8
17	29th ditto .	The Superintendent, Civil Veterinary Department, Burma, Rangoon.	15,050	3,010	VIII	5
		Carried over .	...	...	...	...

Issue—continued.

Serial No.	Date of issue.	To whom consigned.	No. of cubic centimetres.	No. of doses calculated for plains animals per 600 lbs. Body weight by Simultaneous Method.	Laboratory No. of serum.	Standard.
						c. c.
		Brought forward .	...	...	...	...
18	10th November 1901	The Superintendent, Civil Veterinary Department, Bengal.	12,250	2,450	VIII	5
19	20th ditto .	The State Surgeon, Taiping, Perak .	2,100	210	IX	10
20	24th December 1901 .	The Superintendent, Civil Veterinary Department, Bengal.	2,800	280	„	10
...	Ditto .	Ditto ditto .	10,500	1,312	X	8
...	Ditto .	Ditto ditto .	14,000	1,750	XI	8
21	2nd January 1902 .	The Superintendent, Civil Veterinary Department, Provincial Circle, Lahore.	7,000	875	„	8
22	22nd ditto .	Ditto ditto .	12,600	1,145	XIII	11
23	29th ditto .	The Principal, Veterinary College, Lahore.	10,500	954	„	11
24	Ditto .	The Superintendent, Civil Veterinary Department, Bombay, Ahmednagar.	10,500	954	„	11
25	Ditto .	The Superintendent, Civil Veterinary Department, Rajputana, Ajmer.	10,500	954	„	11
26	31st ditto .	The Superintendent, Civil Veterinary Department, Bengal.	10,500	954	„	11
27	21st February 1902 .	Veterinary Assistant Natha Sing, c/o Superintendent, Dehra Dun.	700	64	„	11
28	14th March 1902 .	The Chief Commissariat Officer, Peshawar.	700	64	„	11
		Total .	339,000	47,773	...	...

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX II.

Table showing the amount of Anthrax Serum despatched during the year 1901-1902.

Serial No.	Date of issue.	To whom consigned.	No. of cubic centimetres.	No. of doses.	Remarks.
1	2nd July 1901 .	The Senior Veterinary Officer, Rawal Pindi.	700	70	10 c. c. standard.
2	12th August 1901 .	The Superintendent, Cattle Farm, Hissar.	350	17½	20 ditto.
3	30th August 1901 .	Ditto ditto .	250	12½	20 ditto.
4	2nd October 1901 .	Ditto ditto .	600	60	10 ditto.
5	8th January 1902 .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	1,750	175	10 ditto. } per animal.
6	11th ditto .	Ditto ditto .	1,300	260	5 ditto. } per animal.
		Total .	4,950	595	
		Note.—Utilized in experiments at Muktesar.	167	...	

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX III.

Table showing the number of Locust Fungus tubes despatched from the Imperial Bacteriological Laboratory during 1901-1902.

Month and date of despatch.	Name of person.	Name of station.	No. of tubes.	Remarks.
4th April 1901	The Political Agent, Baluchistan	Quetta	4	
7th ditto	Ditto ditto Shahrig	Shahrig	6	
12th ditto	The First Assistant Resident	Hyderabad	6	
2nd May 1901	The Deputy Collector	Jullundar	4	
3rd ditto	The Director of Land Records and Agriculture, Punjab.	Lahore	12	
3rd ditto	The Deputy Commissioner	Ludhiana	4	
3rd ditto	Ditto ditto	Abbottabad	2	
6th ditto	The Sub-Divisional Officer, Rupar	Rupar	2	
9th ditto	The Political Agent	Quetta	4	
14th ditto	The Collector of	Muzaffarnagar	4	
17th ditto	The Political Agent, Thal-Chotiali	Ziarat	4	
20th ditto	The Assistant Political Agent, Duki	Duki	6	
20th ditto	The Director of Land Records and Agriculture, Punjab.	Lahore	12	
20th ditto	The Deputy Commissioner	Abbottabad	2	
20th ditto	Ditto ditto	Amritsar	2	
23rd ditto	The Political Agent	Quetta	10	
23rd ditto	The Assistant Political Agent, Baluchistan	Loralai	2	
31st ditto	The Deputy Commissioner	Raipur	2	
31st ditto	The Secretary, Special Cemmittee, Manour	Abu	5	
8th June 1901	The Political Agent, Bundelkhand	Nowgong	5	
10th ditto	The Political Agent	Quetta	10	
13th ditto	The Collector of Gooty	Gooty	6	
14th ditto	The Deputy Commissioner	Kohat	5	
17th ditto	The Collector	Sholapur	8	
17th ditto	Ditto	Bijapur	8	
19th ditto	The Director of Land Records and Agriculture, Punjab.	Lahore	12	
19th ditto	The Deputy Commissioner	Gujrat	2	
20th ditto	Ditto ditto	Peshawar	3	
24th ditto	The Civil Surgeon	Hamirpur	3	
25th ditto	The Collector	Nasik	5	
25th ditto	Ditto	Thana	6	
28th ditto	Ditto	Bhagalpore	6	
28th ditto	The Muktiyarkar, Umarkot, Sind	Umarkot	6	
3rd July 1901	The Collector	Nasik	5	
16th ditto	The Deputy Commissioner	Bilaspur, C. P.	4	
	Carried over	.....	...	

Table showing the number of Locust Fungus tubes despatched from the Imperial Bacteriological Laboratory during 1901-1902—continued.

Month and date of despatch.	Name of person.	Name of station.	No. of tubes.	Remarks.
	Brought forward .	.....	...	...
17th July 1901 .	The Superintendent, Siripur Farm, Huthwa Raj.	Siripur . . .	6	
19th ditto .	The Deputy Commissioner . . .	Gurgaon . . .	5	
25th ditto .	Ditto ditto . . .	Jbang . .	2	
25th ditto .	The Director of Land Records and Agriculture, Punjab.	Lahore . . .	10	
27th ditto .	The Collector	Dhulia . . .	6	
20th August 1901 .	The Principal, Jaswant College . . .	Jodhpur . . .	6	
21st ditto .	The Assistant Commissioner . . .	Ajmere . . .	5	
5th October 1901 .	The Collector	Ahmedabad . .	4	
9th ditto .	The Khetiwadi Kamdar, Baroda State .	Amreli . . .	2	
5th November 1901 .	The Collector	Ratnagiri . .	2	
16th ditto .	The Mamlatdar, Khed Dupoli, Deogad .	Ditto . .	2	
21st ditto .	The Political Agent	Kotah . . .	2	
3rd January 1902 .	Ditto	Bikaner . . .	6	
	Total .	.....	245	

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX IV.

Table showing the number of doses of English and French Mallein issued from the Imperial Bacteriological Laboratory during 1901-1902.

Serial No.	Date.	To whom issued.	No. of Doses.	
			English.	French.
1	17th July 1901 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	50	...
2	22nd August 1901 .	The Superintendent, Civil Veterinary Department, Bombay, Ahmednagar.	10	...
3	27th November 1901	The Superintendent, Hapur Remount Depôt, Babugarh	...	75
4	13th December 1901 .	The Officer Commanding British troops, Shanghai .	100	...
5	31st ditto .	The Superintendent, Hapur Remount Depôt, Babugarh	...	50
6	16th January 1902 .	The Principal, Bombay Veterinary College, Bombay .	20	7
7	25th ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Lahore.	5	...
8	28th ditto .	The Superintendent, Hissar Cattle Farm, Hissar .	15	...
		Total .	200	132

ALFRED LINGARD,
Imperial Bacteriologist.

XIX.—IMPERIAL.

Table showing main results of working of the Imperial Bacteriological Laboratory during 1901-1902.

	I QUANTITY OF SERUM OR ANTI-TOXIN PREPARED AND ISSUED.								II PRACTICAL INSTRUCTION IN INOCULATION.			III FINANCIAL RESULTS.											
	Rinderpest Serum. 1			Anthrax Serum. 2			3	4				Receipts.				Expenditure.							
	Prepared.	Issued.	Stock in hand.	Prepared.	Issued.	Stock in hand.			Province.	No. of veterinary Inspectors or Assistants sent to the Laboratory.	No. who passed.	Sale of animals.	Sale of garden products.	Other miscellaneous receipts.	Total.	Salaries and travelling allowances of officers and subordinate establishments.	Feed and keep of animals.	Purchase of animals.	Cost of chemicals and apparatus.	Other miscellaneous expenditure.	Total.		
	c. c.	c. c.	c. c.	c. c.	c. c.	c. c.						R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.		
Muktesar Laboratory.	Opening balance 214,192	Manufactured during 1901-1902 392,246	*						Punjab	32	32	330 6 0	276 0 0	320 7 0	926 13 0	40,906 12 10	5,999 14 7	6,300 0 0	R a. p. 4,999 15 0 5,000 0 0 1,250 0 0 Machinery‡ Library	4,527 9 2	68,984 3 7		
									United Provinces	7	7												
									Bombay	10	10												
		354,591	251,847	11,891	5,117	6,774	*Nil.*	*Nil.*	Sindh	3	3												
									Berar	1	1												
									Native States	2	2												
Bareilly Depôt	...	...	... *	...	...	...	...	...	...	...	... *	...	...	... †	...	...	...	...	...	72 0 0	72 0 0		
	606,438	354,591	251,847	11,891	5,117	6,774	...	...	...	55	55	330 6 0	276 0 0	320 7 0	926 13 0	40,906 12 10	5,999 14 7	6,300 0 0	11,249 15 0	4,599 9 2	69,056 3 7		

* This consists of 115.540 c. c. Tested serum equivalent to 23,108 doses at 5 c. c. per 600 lbs. body weight ssimultaneou method.

† Includes R115, cost of serum despatched to Perak.

‡ Out of this R1,700 machinery was purchased, and the balance (R3,300) was asked to be transferred to the Director General of Stores, India Office, to pay for a Petroleum Motor.

ALFRED LINGARD,
Imperial Bacteriologist.

G. I. C. P. O. No. 220 R. & A.—24-9-1902.—270.—Wallis.

1902.

File No. 108 of 1902.

Serial No. 2.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

CIVIL VETERINARY ADMINISTRATION.

RESOLUTION.

No. 21—108-2.

Dated Simla, the 25th August 1902.

SUBJECT.

Annual Report of the Imperial Bacteriologist for the year 1901-1902.

G. C. Press, Simla.—No. 695 R. & A. D.—1-9-1902.—300.

DEPARTMENT OF REVENUE AND AGRICULTURE.

File No. 108 of 1902.

Simla, the 25th August 1902.

Serial No. 2.

No. 21-Civil Veterinary Administration.

Resolution by the Government of India, Department of Revenue and Agriculture.

READ—

Letter from the Inspector General, Civil Veterinary Department, No. 154-209 R. & A., dated 8th July 1902, forwarding the Annual Report of the Imperial Bacteriologist for the year 1901-1902.

Letter to the Director General, Indian Medical Service, No. 862—49-1, dated 19th March 1901.

Letter to the Director General, Indian Medical Service, No. 3234—108-2, dated 23rd August 1901.

The Imperial Bacteriologist and his staff were mainly occupied during the year in the manufacture and testing of rinderpest serum. Experiments were continued with a view to improve the protective quality of the serum produced and to perfect the process of manufacture. Results obtained at Jacobabad, Madras and Rangoon, showed that the initial protective value of sera is materially diminished by exposure to high temperatures. The Government of India have observed with interest the results of the experiments carried out in different localities to ascertain the strength of doses required to secure protection in different breeds of cattle, and hope that Dr. Lingard will continue his researches in this direction, and that he will submit in due course a special report describing the result of his further experiments on the best method of obtaining a serum.

2. Further investigations on the subject of Anthrax were brought to a successful issue in the discovery of a protective serum. Researches were also carried out in connection with other animal diseases including Lymphangitis Epizootica, Surra and Paralysis.

3. The Government of India notice with satisfaction the increasing demand for serum, of which 47,773 doses were issued against 24,232 doses issued last year. They are gratified to learn the highly successful results obtained in Bengal by Veterinary Major Raymond and in Burma by Veterinary Captain Evans. The present report gives no information regarding the results obtained in other Provinces and the Governor General in Council desires that the work of all officers should be briefly summarised in future Reports, the detailed results in each Province being dealt with in the Provincial Veterinary Reports. Under the scheme recently sanctioned for the enlargement of the Imperial Bacteriological Laboratory, it is hoped that the output of serum will be increased to 1,00,000 doses per annum.

4. The scheme for the training of Veterinary Assistants at the Bacteriological Laboratory in the inoculation of cattle against rinderpest has been successful. During the year under report 55 assistants were trained and all passed. Of this number Punjab sent 32, Bombay and Sindh 13, and the United Provinces 7. It is hoped that other Provinces, especially Burma and Madras, will see the advantage of sending assistants to the Laboratory for training.

5. The reports which have been received from time to time show that no successful results have yet been obtained in any Province from the use of Dr. Edginton's method of exterminating locusts. It has therefore been decided to discontinue the issue of the fungus tubes pending the result of further investigation and experiments, which will be carried out by the Imperial Bacteriologist in collaboration with the Inspector General of Agriculture.

6. In conclusion, the Governor General in Council desires to acknowledge the excellent work done by Dr. Lingard and his staff during the year under report.

Madras.
Bombay.
Bengal.
United Provinces of Agra and Oudh.
Punjab.
North-West Frontier Province.
Burma.
Central Provinces.
Assam.
Ajmer-Merwara.
Hyderabad.

7. Ordered, that the above Resolution be forwarded to the Local Governments and Administrations noted on the margin for information.

Ordered, also, that the Resolution be forwarded to the Military Department for information, and to the Foreign Department for information and for favour of communication to the Honourable the Agent to the Governor General, Baluchistan.

Ordered, also, that the Resolution be published in the Supplement to the *Gazette of India.*

[True Extract.]

J. O. MILLER,

Offg. Secretary to the Government of India.

3

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1902-1903.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1903.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1902-1903.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1903.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1902-1903.

Section I.

Research.

Rinderpest.—During the year under report experiments were continued and concluded for the present, with a view to determine the best method of producing a serum possessed of the highest protective value and in the shortest possible time. The full detailed results of this prolonged research which has now occupied a period of 3½ years will be submitted in a separate report. The results, however, of the above investigations as they were worked out have been recognised and full advantage taken of any modifications which tended to increase the value and efficacy of the serum under preparation.

2. In addition to the preparation of different kinds of sera including Rinderpest, Anthrax and Hæmorrhagic Septicæmia, together with the routine work of the Laboratory, I have utilized all my spare time during the last 3 or 4 years in the elucidation of the following problems which I set before myself in 1897:—

(i) Whether it could be determined what are the constituents (or constituent) of the 5th or 6th day rinderpest bile which conferred immunity.

(ii) Whether, if determined, they could be so collected and separately utilized as to *per se* confer immunity.

3. The brief results of Nos. (i) and (ii), *viz.*, the influence of Nucleo-proteid in the conferment of immunity against rinderpest, by rinderpest bile, are summarized as follows:—

(1) The mucoid material present in the biles of bovines and buffaloes appears to be Nucleo-proteid only.

(2) The Nucleo-proteid in all Hill animals injected with virulent rinderpest blood increases rapidly on each successive day of the disease until death or recovery ensues.

(3) The marked increase in N. P. in Control Hill bulls during an attack of rinderpest, occurs on the 6th day of disease, but the maximum is probably attained on the 8th day.

(4) In Control Hill bulls, the sudden rise of N. P. is shown to occur on the 8th day following inoculation, instead of 9th day, *i.e.*, the day equivalent to the 6th day of disease, but the maximum is attained on the 11th day. This discrepancy may be accounted for by the facts that in a large number of animals the premonotory rise in temperature occurred in 2½ days, instead of after 3½ days period of incubation, and all such cases have been massed together for the purpose of abstracting these results.

(5) In Hill bulls which received protective serum and blood simultaneously, the N. P. commences to increase on the day following inoculation.

The subcutaneous injection of protective serum would appear to produce an immediate effect on the lining membrane of the gall-bladder and hence an increased production of the Nucleo-proteid.

(6) The marked increase in N. P. in animals injected by the simultaneous method occurs on the 7th and 8th day of disease and on the 11th day following inoculation. On comparison of this result with that obtained in Control Hill bulls, the sudden increase of N. P. appears one day later; this may be explained by the facts that the effect of the injection of the protective serum appears to prolong the period of incubation.

(7) The amount of N. P. in the bile of healthy young bovines is at its minimum previous to inoculation. The maximum amount in Serum Testing animals is attained on the 12th day of disease and 14th day following inoculation, after that date a gradual diminution in the amount of N. P. appears to take place, but the minimum according to our data, never falls to that found in health.

It is but reasonable to account for the difference in the percentage of N. P. found at the height of the disease and when death takes place during recovery, on the supposition that the N. P. is re-absorbed into the system, in order to act as a recuperative or defensive agent, for it is difficult to suppose that nature provides this increase of a highly organised product simply to be voided from the system as a waste material.

(8) The marked rise in N. P. in Hill buffaloes injected with rinderpest blood only, takes place on the 7th day of disease, not on the 6th day as in bovines, for the first symptoms of the disease in such animals appear on the 7th or 8th day following inoculation.

(9) A comparison of the amount of N. P. in the bile of healthy and susceptible full grown plains and hill cattle and buffaloes with that in the bile of the same animals at death, after subcutaneous inoculation with the *materies morbi* of Rinderpest and Anthrax, indicates a considerable increase. Taking as a unit the amount of N. P. in health, the multiple at death for each class of animal were as follows:—

Rinderpest	Plains bulls	4·20 to 105·21
	Hill do.	3·12 to 7·22
	Do. buffaloes	1·52
Anthrax	Plains bulls	6·13
	Hill do.	3·40

(10) The bile collected from the gall bladders of Plains and Hill cattle and buffaloes, which had not been inoculated, but which succumbed to Gastro-Enteritis from bad feeding during the hot and famine seasons, was found to contain a much larger amount of N. P. than in health, as may be seen in the following table:—

Animals.	% N. P. in grammes, in healthy young animals.	% N. P. in grammes, following Gastro-Enteritis.			Percentage ratio of N. P. columns 1 and 4.
		Minimum.	Maximum.	Mean.	
	1	2	3	4	5
10 Hill buffaloes	0·0250	0·1406	1·0880	0·3591	1 : 14·36
56 Hill bulls	0·0175	0·0640	2·2220	0·3693	1 : 21·10
13 Plains bulls	0·0124	0·0968	1·0360	0·3906	1 : 32·14

It would thus appear that a mechanical irritation or simple inflammation of the lining membranes of the stomachs and intestines of bovines and buffaloes, is sufficient to stimulate and cause an increase in the output of N. P. from the m. m. of the gall bladder without the presence of a disease due to a particulate *contagium*.

(11) N. P. may be precipitated from rinderpest bile. It may be collected in a fairly pure state after reprecipitation and washing on several occasions.

Note.—N. P. indicates Nucleo-proteid of bile, removed direct from the gall-bladder.

(12) When the dry N. P. obtained from rinderpest bile is made soluble in weak sodium carbonate solution and mixed in certain proportions with virulent rinderpest blood and allowed to stand for a certain period *in vitro*, it has the power of completely neutralizing the *contagium* of this disease.

(13) Bovines (plains) and buffaloes (plains and hill), injected subcutaneously with varying quantities of N. P. (made soluble in weak rinderpest bile) equivalent to the amount of N. P. found in the biles of hill cattle which succumbed to rinderpest on the 4th, 5th, and 6th days of disease, were found when tested 10 days later with virulent blood, to succumb or recover according to the amount of N. P. they respectively received.

4. *Results of experiments with rinderpest bile and its N. P.*—(1) An active immunity, which in most cases only commences to be developed on the 5th day following the injection of bile, can only be brought about when the *contagium* of rinderpest is present in an active form in the injected bile.

(2) A *passive* immunity commences immediately after the subcutaneous injection of rinderpest bile, and is brought about by the action of the contained N. P. and Lecithin; the quantities of these bodies in the injected bile alone determine the degree and length of time during which the *passive* immunity will persist.

(3) A rinderpest sixth day bile which has been kept for some days and has had glycerine or other chemicals added to it for the purpose of keeping it aseptic, can never on subcutaneous injection into a susceptible animal, whatever quantity be administered, confer anything more than a transitory *passive* immunity.

(4) Of 235 samples of rinderpest bile withdrawn from the gall-bladder of bovines with due antiseptic precautions during the 3rd to the 9th day of the disease—and cultures made in each instance—78 or 33·19 per cent. remained sterile, while in 175 or 66·81 per cent. of the cultures varying amounts of bacterial growths made their appearance.

(5) When rinderpest and normal biles are drawn into sterilized flasks direct from the gall-bladders of diseased or healthy bovines, with due antiseptic precautions—samples of the bile taken at the time of collection and after varying periods for the purpose of estimating the N. P. present, it will be found in the majority of instances that there is a gradual diminution of the contained N. P. as time advances due to the consumption of the proteid by the micro-organisms present in the different samples of bile submitted to examination.

(6) Susceptible animals injected subcutaneously with a fresh and powerful sixth day rinderpest bile acquired an *active* immunity lasting from three to five months. The same breed of animals injected with the same quantity of bile but previously passed through a Pasteur-Chamberlain filter acquire an evanescent immunity *passive* in character, which lasts for a short period only. Animals subcutaneously injected with the 6th day bile or from the filtrate obtained under pressure from the second mentioned bile, from which in both instances all trace of N. P. has been removed acquire no protection whatsoever and on being inoculated with 0·50 c. c. of rinderpest blood succumb as quickly to the disease as an unprotected or susceptible control. Whereas animals injected with the material remaining inside the filter acquire an *active* protection.

(7) In no instance have hill bovines, buffaloes, or goats shown symptoms of rinderpest when injected subcutaneously with fresh bile of a rinderpest animal withdrawn from the gall-bladder on the 3rd, 4th, or 5th day of the disease.

(8) Hill cattle subcutaneously injected with quantities varying from 10 to 188 c. c. of sweet, green rinderpest bile taken on the 6th and 7th day of the disease respectively, succumbed to well marked rinderpest when inoculated with 0·5 c. c. virulent blood, ten full days after the date of the injection of bile. When larger doses than 180 c. c. were injected, death occurred within a few days, preceded by symptoms of poisoning, the most marked being tetanic movements of the limbs.

(9) Rinderpest bile utilized in 10 c. c. doses before the 5th or 6th day of the disease rarely confers immunity. The *contagium* of rinderpest only effects an entrance into the bile in the gall-bladder on the 5th or 6th day of

the disease. Previous to its entry the amount of N. P. contained in the injected bile is generally sufficient to bring about a passive protection, but when the 6th day bile is utilized with the "materies morbi" of rinderpest present, the contagium is more or less kept in check by the action of the N. P. present, and produces in the injected animal a very modified form of the disease, but nevertheless the result is a transitory *active* immunity which may persist for a period of 3 to 5 months, according to the degree of virulence possessed by the contagium in the injected bile. Further, on the 5th day of the disease the average percentage of N. P. is only 0·5063 grammes per cent., the multiple of increase of N. P. being 28·93 per cent., whereas on the 6th day the average percentage of N. P. jumps up to 1·1160 grammes per cent. or a multiple of increase of 63·77 times more than the average found in healthy young hill cattle. A total increase of more than 100 per cent. in 24 hours. Consequently if the 6th day bile utilized for the purpose of injection should fail to bring about a transitory *active* immunity owing to absence of rinderpest *contagium* from the injected bile, the amount of N. P. present would in plains cattle be sufficient to produce a passive immunity which could be changed into an active immunity by the inoculation of virulent blood, several weeks later.

5. *Normal Bile and its N. P.*—The most important result of Normal Bile and its N. P. is that a passive immunity can be conferred on plains cattle and buffaloes against rinderpest after successive doses of normal bovine bile containing N. P. and Lecithin in sufficient quantities.

6. *Serum experiments.*—In last year's report the results obtained with the serum deposited at Jacobabad, Madras, and Rangoon were recorded, showing a material diminution in the initial protective value of sera when exposed to high temperatures. During the year under report similar experiments were carried out with the serum deposited at Meerut, Muktesar, and Quetta. The following is a short resumé of the results obtained :—

7. *Meerut.*—On the 26th November 1900, 2,380 c. c. of No. VIII serum were issued to the Assistant to the Inspector General, a certain quantity was utilized and the remainder was deposited in Meerut (United Provinces) until 27th January 1903, when it was despatched to Muktesar and received on the 7th February 1903, being retested on the 12th March 1903. After having been exposed for a period of 26 months including two hot seasons in Meerut, maximum shade temperature in 1901 rising to 107·7° F. and in 1902, 103·8° F., it was found to have lost 55 per cent. in protective power, *i.e.*, a hill animal required a dose of 200 c. c. per 600 lbs. body weight to bring about protection by the simultaneous method instead of 90 c. c. as standardized at the time of issue.

The same serum, *viz.*, No. VIII, which was deposited in the office of the Collector of Jacobabad on the 17th of January and retained there until the end of July, 1901, exposed to a maximum temperature of 126° F., was found last year on being retested at Muktesar, to have lost 66·6 per cent. in protective power.

It will therefore be observed from the above experiments that when samples of the same serum were deposited in (*i*) Jacobabad for a period of 6½ months maximum shade temperature rising to 126° F., (*ii*) in Meerut for a period of 26 months, including two hot seasons, maximum shade temperature rising to 107·7°F., the former sample lost 66·6 per cent., whereas the latter only lost 55 per cent.

8. *Muktesar.*—No. XI serum was prepared during the months of September to November, 1901, and was utilized for the serum test experiments carried on in Cawnpore, Central Provinces, and Poona in January and February, 1902, also for the Bengal and Madras experiments by Mr. Stockman during the past few months, and in addition for testing the Lucknow, Jalaun, and Meerut breeds of cattle between December, 1902, to March, 1903.

The unused serum has been kept in the cold room at Muktesar and only forwarded to the plains when required for the above mentioned experiments.

It nevertheless was deemed advisable, during the present winter, to retest it in order to ascertain whether the protective value had decreased since it was prepared and standardized 16 to 17 months ago. These latter experiments have proved that the protective value of No. XI serum as issued at 126 c. c. for hill

and 7 c. c. for plains per 600 lbs., has remained unaltered, which is a further proof that sera may be kept at the temperature of Muktesar without undergoing deterioration as a result.

9. *Quetta.*—On the 20th July, 1902, 2,800 c. c. of No. XII sera were issued to the Superintendent, Civil Veterinary Department, Baluchistan and Sindh, Quetta. It was retained in his office, in a dark room, during a period of 9½ months and was exposed to a maximum shade temperature rising to 98·6° F. This serum was prepared at Muktesar during November, 1901, to February, 1902, and tested on hill animals during the months of March and April, 1902, when its protective value was standardized at 5 c. c. for plains and 90 c. c. for hill animals, per 600 lbs. body weight. On the 12th May, 1903, it was received at Muktesar and after retesting, it was found to have deteriorated in protective power from 5 to 7 c. c. per 600 lbs. body weight. The question now arises as to whether serum forwarded during the hot season to a station a long distance off, as Quetta from Muktesar, will deteriorate in value, if it has to pass through a portion of the country exposed to a very high temperature, as for instance by Ruk Junction, Jacobabad, Sibi to Quetta. In a previous report it was found that serum retained in the Superintendent's office, Rangoon, exposed to a maximum temperature of 104° F., was equally efficacious either by the serum alone method or by the simultaneous method, after injecting the Laboratory standard doses. As no evidence is at our disposal as to what length of time this serum was exposed in the plains previous to its being deposited in Quetta, it is at present impossible to give a final opinion on the course of its deterioration in value.

10. *Lucknow, Jalaun, Meerut and Moradabad experiments.*—In accordance with the orders of the Government of India conveyed in their Resolution No. 21—108-2, dated 25th August, 1902, Revenue and Agricultural Department, to the effect that "the Government of India have observed with interest the results of the experiments carried out in different localities to ascertain the strength of doses required to secure protection in different breeds of cattle and hope that Dr. Lingard will continue his researches in this direction", arrangements were made to carry out experiments with Lucknow, Meerut, and Jalaun cattle at the Bareilly Depôt during the winter months.

A full and detailed report of the results of these experiments was forwarded to Government on the 11th May, 1903, together with temperature charts of the respective animals and an album containing photographs of nearly all the cattle (68 out of 70) utilized during such experiments.

The following short resumés of the results obtained in the cattle of the respective districts of the United Provinces experimented with are here recorded.

11. *Experiments with Lucknow bulls.*—Of the three Controls inoculated with virulent blood, one succumbed to severe disease, while a second passed through a fairly severe attack, the third showing a thermal reaction but no other symptoms. Of the 21 animals inoculated by the simultaneous method all those which received 7 c. c. (the standardized dose for plains cattle) and above, of the protective serum recovered, while of the 6 animals which received 1 and 2 c. c. short of the standardized dose, one succumbed to a severe form of the disease, two presented severe symptoms and recovered and others showed more or less thermal reactions and no symptoms.

This series of experiments prove that probably a dose of 6 c. c. per 600 lbs. might have been sufficient to protect by the simultaneous method but that 7 c. c. per animal by the serum alone method would have been ample to secure immunity during an outbreak of disease in the district.

12. *Jalaun bulls.*—One animal, out of 4 controls, inoculated with virulent blood succumbed to a severe form of disease, while a second presented a thermal reaction with slight symptoms, *i.e.*, only 50 per cent. exhibited signs of rinderpest at all, while the other half showed no symptoms. As these animals only varied between 2 and 4 years of age, it would appear that the animals obtained from the Jalaun District possessed a considerable degree of either acquired or hereditary protection, probably the latter. Of the 19 animals varying in age between 2 and 4 years and one only of 6 years which received protective serum and blood by the simultaneous method all recovered even those 6 which received 1 to 2 c. c. below the standardized dose of 7 c. c.

We may therefore assuredly assume that 7 c. c. administered by the serum alone method would be sufficient to carry such cattle through the period of an outbreak of rinderpest in the district.

13. *Meerut bulls.*—Of the 24 head of cattle inoculated, 3 were utilized as control animals and 20 were inoculated by the simultaneous method with doses of anti-rinderpest serum ranging between 5 and 15 c.c. per 600 lbs. body weight. As none of the three former or controls inoculated with virulent rinderpest (hill blood) succumbed to the disease, one was not surprised to observe that only 5 out of 20 or 25 per cent. of the number which received serum, showed any marked symptoms of rinderpest. This breed of cattle from the Meerut District would therefore be fully protected by the serum alone method when doses of 5 to 7 c.c. were administered, and such doses should give sufficient protection to guard against rinderpest during a period of several months.

14. *Moradabad.*—Fourteen animals varying in age between 2¾ and 4 years were submitted to the simultaneous method with serum No. XIV, the protective value of which was previously estimated to be 10 c.c. per 600 lbs. for plains cattle and 180 c.c. per 600 lbs. for hill cattle. Six of their number presented neither symptoms of rinderpest nor thermal reactions. Four presented fair thermal reactions varying between 40·1 and 40·4° C., with slight symptoms of the disease; whereas the third series numbering four animals exhibited high temperatures varying between 40·7 and 41·5° C., but only two of the number showed other manifestations, *viz.*, a few vesicles.

The affected animals made a rapid recovery and were shortly after utilized for the preparation of serum.

15. *Anthrax.*—Experiments with regard to the preparation of a protective serum against Anthrax in cattle, etc., have been continued specially with a view to the production of sera possessing high protective value. As anticipated in last year's report, the period which must elapse between the initial injection and the date of bleeding has been reduced in duration, but even now it has been found necessary after one bleeding for serum that a further injection of virulent material should be made before a subsequent withdrawal of blood can be entertained, if the protective value of the serum is to be maintained. Therefore it will be seen that unless large number of animals are injected for the purpose of production of such sera the output cannot be anything but small and until the shed accommodation sanctioned by the Government is provided and is ready for occupation, the necessary space for Anthrax cattle is limited and cannot be increased.

16. *Barbone* or Hæmorrhagic Septicæmia of buffaloes and bovines.*—This almost ubiquitous disease of buffaloes and cattle was first *clinically* known and described in buffaloes by Metaxa in 1816, and during the past decade has received considerable attention from bacteriologists.

17. During the rainy season of 1902, Veterinary-Captain G. K. Walker with the assistance of Mr. Jethiji, Civil Veterinary Department, was enabled to procure for me pathological material from one or more buffaloes which succumbed to 'Barbone' in the Punjab.

18. The organism, the cause of the disease, is a short bacillus, ovoidal, with rounded extremities. The organism when stained presents the two terminal portions coloured with the intervening or middle portion uncoloured. The bacillus varies considerably in size, the largest specimens having been always obtained from the spleen of the rabbit.

19. Rabbits are the most susceptible of all animals experimented with to the organism of Hæmorrhagic Septicæmia. They succumbed in from 11½ to 20 hours after the subcutaneous inoculation of 0·05 c.c. bouillon culture incubated at 37° C. for 48 hours. The following animals succumbed to inoculation, after doses of 0·10 to 0·20 c.c. of bouillon cultures, in the periods stated below:—

Buffaloes in 28 hours,
Plains bulls in 28 to 42½ hours,
Hill bulls in 23½ hours,
Donkeys in 17 to 23½ hours,
Pigeons succumbed in from 46½ to 278 hours.

* Synonyms:—Barbone dei bufali, Wild und Rinderseuche, Pasteurellosis bovis, Malignant sore throat (India). Ghotwa, Gharrwa or Galghotu (Southern Punjab), Khounnaq (strangles) Egypt. Sakit Ngorok (Exanthematous) and Koerang Naplas (pectoral form) Java.

Rats (Mus decumanus), some succumbed and some proved refractory both to the inoculated disease as well as to feeding experiments. The following animals and birds, *viz.*, ponies (hill and plains breed), sheep, goats, dogs, cats, and fowls received large doses of bouillon cultures, 0·1 c.c. of which killed susceptible cattle, but all proved refractory.

20. Young hill cattle 1 to 3 years of age were found to be more susceptible than full-grown and older animals of the same breed, when primarily injected with certain biles collected from animals which had succumbed to Hæmorrhagic Septicæmia, and later tested with 0·2 c.c. of virulent bouillon cultures. The former died whilst the latter recovered.

21. One attack of the disease confers immunity, but for what period in this country has not yet been ascertained.

22. The organisms of the disease which are said to remain virulent for a period of ten months in cultivation were found to have lost all power of reproducing the disease when kept at Muktesar, 7,500 feet elevation between November 17th, 1902, and April, 1903, lowest temperature recorded during the interval, 24·8°F.

23. The typical organism of Hæmorrhagic Septicæmia can readily be obtained from the body cavity of ticks (Ixodes) collected from affected animals during the latter portion of the course of the disease or at the time of death. The organism can be recovered in artificial cultures from the blood in the body cavities of such ticks and the cultures have been found to retain their virulence for rabbits. It is more than probable that female ticks replete with blood from Hæmorrhagic Septicæmia animals do drop off and when the cycle is complete, the young in their turn are the means by which the disease is conveyed to other animals, as is the case with the "Piroplasma bigeminum" in Texas or Tick Fever.

24. In a recent outbreak of spontaneous Septicæmia in rabbits, during which some 30 or more animals succumbed to the disease, they presented in their blood an organism identical in form, etc., to that found in Hæmorrhagic Septicæmia. Blood teeming with the typical bipolar staining organism and bouillon cultures of the same, failed to produce any effect when injected subcutaneously in plains cattle.

25. The practical results of this prolonged investigation will be found in Section II.

26. *Hæmoglobinuria* or Red water in cattle and buffaloes.*—At the end of December, 1902, I informed the Inspector-General by letter, that Hæmoglobinuria or Texas Fever had made its appearance spontaneously in Plains cattle at Bareilly Depôt, some days after being inoculated with rinderpest blood obtained from hill cattle at Muktesar.

27. This disease has been recognised for years in this country and was clinically described by Veterinary-Colonel J. H. B. Hallen in 1871. Cattle, buffaloes, and sheep are liable to the disease, and as has been observed both in Europe and India, frequently the females of the above species are attacked shortly after parturition.

28. The disease is due to the presence of the "Piroplasma bigeminum" in the red corpuscles, the white corpuscles remaining unaffected; it can usually be transmitted to healthy and susceptible cattle by intravenous and subcutaneous inoculation of infected blood, but not by large doses of infected blood *per os*. The symptoms are usually less severe in young animals. The organism may be recognized microscopically in the blood of the general circulation previous to the presence of the Hæmoglobinuria.

29. One attack of the disease confers an active immunity for a period of several years.

30. The chief points of interest with regard to the cases of Hæmogobinuria noted, were: —

Animals pasturing on undrained land or land subject to flood, and drinking the water of boggy lands are most likely to contract the disease in India.

---

*Synonyms:—Texas Fever, Southern cattle fever (United States America).
Tristeza (Argentina).
Rindermalaria and Rothe-krankheit (Germany).
Tick Fever (Australia).
Red water, black water or bloody urine, Lal peshâb (Hindi), Rokto mootra (Bengali).
Rodsyge (Norway).

Of the two cattle observed with Hæmoglobinuria, one was brought from near the Ramganga river and the second from a district bordering on the Jamna river.

Both animals were subcutaneously inoculated with virulent rinderpest blood one six weeks later than the other, but in both instances the symptoms of rinderpest were followed by those of Hæmoglobinuria before those of the former disease had disappeared from the affected animals, and on microscopical examination of their blood 60 and 62 per cent. respectively of the red blood corpuscles were found to contain the organism of the disease.

31. The control rinderpest blood utilized for inoculation purposes was found to be free from the *materies morbi* of the disease, and no other cattle, out of some 90 inoculated, showed symptoms of Hæmoglobinuria, so that the disease was not contracted at the Bareilly Depôt from the injected rinderpest blood.

32. Five plains bulls, several of which had only just passed through attacks of inoculated rinderpest, and one unprotected hill bull were each subcutaneously inoculated with (1 plains 1 c.c., 1 hill bull 1 c.c., and 4 plains 10 c.c.) blood drawn from the animals suffering from Hæmoglobinuria, the red corpuscles of which contained the "Piroplasma bigeminum." No thickening appeared at the seats of inoculation, a slight rise of temperature occurred in one plains animal, maximum 39·0°C., on the 5th evening. The "Piroplasma bigeminum" was not discovered in the blood of any of the inoculated animals and therefore Hæmoglobinuria never appeared as a symptom.

The hill animal subsequently inoculated with 1 c.c. of virulent rinderpest blood succumbed to a severe attack of the malady on the 7th day of disease, and 10th following inoculation. No organisms (Piroplasma bigeminum) were discovered during the course of the disease.

33. It would therefore appear that the "Piroplasma bigeminum" is able to lie dormant in the systems of some of the plains cattle in this province, until such time as the restraining power present in the blood has been modified or removed, when it again assumes an active state; and the reduction or entire removal of the hereditary or acquired resistance to the organism may in some cases (perhaps when such protection is passing off) be materially hastened by such animal passing through an attack of (inoculated) rinderpest.

34. The blood of bovines which have shown symptoms of this disease and in which the "Piroplasma bigeminum" has been present in large numbers for several days, contains a most powerful toxin, a small quantity (1 c.c.) of which is capable of killing a small animal within a few minutes at most, subsequent to subcutaneous inoculation.

35. The plains and hill bulls inoculated with 1 c.c. and 10 c.c. doses respectively failed to react to the inoculated blood, although it contained a certain number of the "Piroplasma bigeminum" which microscopically were undergoing a marked change.

It would appear that either an hereditary or acquired resistance must be possessed by plains and hill bovines alike although collected from districts so far apart, or that the presence of the powerful toxin when found in the blood must exercise an influence on the organism of the disease, so as to inhibit its action or destroy it altogether.

36. Ticks (Ixodes) more or less replete with blood were picked off the bodies of the affected animals. On microscopical examination of the contained blood, the red corpuscles were found to contain the (Piroplasma bigeminum) organisms of the disease.

37. *Surra in camels.*—For some years it has been known that although a large percentage of camels which are attacked with Surra succumb within a few months to the disease, nevertheless, a few camels which are able to withstand the repeated paroxysms of this affection during several years (Tebersa) may recover and camel attendants aver that such animals have not been observed to be again attacked by this disease.

In September, 1896, I obtained the sanction and approval of the Government of India to investigate the course of Surra (Tebersa) in camels, but no opportunity occurred until last cold season when the Bareilly Depôt was opened for work.

38. For the above observations three camels were obtained :—

(i) Supposed to be a quite recent case, No. III, ten years of age,

(ii) Attacked with Surra three months before arrival, No. I, six years of age,

(iii) Attacked with Surra 8th June, 1901, No. II, eight years of age.

Daily microscopical observations were made and maintained for a period of 140 days (23rd November, 1902, to 11th April, 1903), with a view to obtain an exact knowledge of the life history of the organism, during the paroxysms and intermissions of this disease, in order to discover whether the "Trypanosoma" differs in any way from that observed in Equine Surra.

39. Further other important questions propounded with a view to their elucidation were placed "en train," *viz.*:—

(i) Will inoculated Surra, conveyed from camels to Equines,—when the "materies morbi" of the disease utilized is obtained during the early period of the malady,—bring about a fatal termination in the inoculated animals ?

(ii) If a fatal termination occurs in No. (i) experiment, may not a time arrive during the prolonged course of Surra in some camels, when the Trypanosoma will fail to bring about a fatal termination in Equines ?

40. With regard to the most important result obtained up to the present, in a pony inoculated with 1·0 c.c. of blood from a Surra camel, containing Trypanosoma in large numbers, the animal after a period of 116* days—on 85th of which the Trypanosoma was present in the circulation,—has been found to be in a far better condition than when inoculated, and has not as yet exhibited any of the marked symptoms so common to inoculated Surra in Equines.

It may here be mentioned that in the absolutely fatal disease in Equines, the usual length of time elapsing between the first day of disease and death in inoculated cases varies from 20 to 56 days, so that the animal under observation has now survived for a period twice as long as the maximum period in an animal the subject of inoculated *Equine* Surra.

41. Of course, the above-mentioned three camels remain under observation together with experimental animals, and it is hoped that further developments from the point of view of conferring immunity on Equines, through the medium of the camel Trypanosoma, may be a result of the continued research.

42. I may mention that one outcome of the investigations with regard to Surra in India, has been the wide dissemination of my Surra reports, both in the eastern and western hemispheres, and during this winter an American commission from the Philippine Islands headed by Brigadier General Wint, United States Army, was deputed by the Commander-in-Chief in India, to visit Bareilly and obtain from me all possible information with regard to the intimate etiology and treatment of Surra in this country.

43. *Dourine.*—In my letter No. 271, dated 24th April, 1900, to the Secretary to the Director-General, Indian Medical Service, I requested that information might be forwarded to me with the regard to the occurrence of a disease in stallions and mares known under the name of Dourine or 'Maladie du coit.' The Department of Revenue and Agriculture in their No. 815—76-2, dated 9th June, 1900, signified the following order :—

"The necessary instructions have been issued to the Inspector-General, Civil Veterinary Department, and the Principal Veterinary Officer in India to keep Dr. Lingard informed from time to time of the occurrence of any case or cases of a certain disease 'Dourine' allied to Surra, as well as any information that may be obtainable concerning them."

44. The first case recognized was that of a stallion Quarter Arab at Babugarh, in July, 1901, inoculation experiments conducted with blood from the plaques and from the general circulation proved negative, but useful photographs were secured of the animal showing the plaques.

45. Since 1902, two animals, an Arab and an English stallion, have been received from Veterinary-Major H. T. Pease, Principal, Veterinary College, Lahore, and at present the disease is being closely studied in English, Arab and Australlian stallions and Australlian and country mares.

---

* The same remark holds good 158 days after inoculation.

46. Much further time and labour will have to be expended before a thorough grasp of the peculiarities of the disease as observed in this country can be arrived at, and therefore a longer period must elapse before any practical results can be hoped for. In the meantime, every advantage is being taken of recording by photographic methods the most important symptoms exhibited in the different animals affected, and drawings made of the different phases in the life history of the Trypanosoma of Dourine.

47. *Human Tubercle.*—The results of Professor Koch's experiments in Europe showed that bovines inoculated with the "materies morbi." of human tuberculosis failed to bring about any pathological changes in the inoculated animals; with a view to discover whether the same results would be obtained with bovines in this country, the following experiments were conducted.

48. Bull, age 3 years, body weight 190 lbs. was intravenously injected on 12th June, 1902, with 4 c. c. of a cultivation of tubercle bacilli derived from human sputum grown in glycerine bullion.

During June to September, 1902, the temperatures varied between 36·8-37·0°C. in the morning and 39·5-40·3°C. in the evening. On the 18th September, 1902, the same animal was injected intravenously a second time with 3·0 c. c. human tubercle bacilli grown in glycerine bouillon and during October, 1902, to May 1903, the temperatures varied between 36·3-37·9°C. in the morning and 38·8-40·6°C. in the evening. The animal was destroyed on the 11th May, 1903, and its dead body weight was found to be 261 lbs. against 190 lbs. at the time of injection. The post-mortem examination revealed no sign of tubercular change in the organs or lymphatic glands; organs healthy.

49. *Hill bull,* age 1 year, body weight 191 lbs., was intravenously injected on 10th October, 1902, with 1·20 c.c. of fresh sputum containing a large number of tubercle bacilli obtained from a case of human tuberculosis of lungs. The sputum was mixed with 6·0 c.c. of 0·6 per cent. salt solution just previous to injection. The evening temperature during a period of nearly 6⅔ months varied between 39·1 and 39·7°C. Except on one occasion it rose to 41·2°C. in November. The morning temperatures varied between 36·4 and 37·4°C. On April 30th, 1903, after an interval of 203 days (body weight 247 lbs. showing an increase of 56 lbs.) the bull was destroyed and a postmortem conducted with the result that no sign of tubercle in any form could be discovered in any of the organs or lymphatic glands.

50. Control experiments were at the same time made in rabbits with the result that these animals succumbed in an average of 92 days after inoculation.

51. *Result.*—The bacillus of tubercle obtained from a human source is unable to reproduce the disease in bovines. There is therefore an indication that tuberculosis in human beings might be retarded, if not cured, by the continued administration during a long period of healthy bovines serum either subcutaneously or *per os.*

Section II.

Application of the result of research.

52. *Rinderpest.*—During the year under review, 473, 471 c.c. of anti-rinderpest serum have been prepared and 539,600 c.c. or 87,791 doses were issued, as per detail shown in Appendix I. The serum prepared is equivalent to 73,288 doses, as against 52,187 doses during the past official year. The demand for this serum was greater by 40,018 doses than that of the last year.

53. Owing to the budget provisions having been made under the new scheme, sufficient funds were at our disposal to facilitate the increased output of serum and therefore we were in a position to prepare 21,101 doses more than that of the previous year. Unfortunately, as the large centrifugal machine and oil engine did not arrive in India and none of the required buildings were taken in hand during the past official year, it was impossible to increase the full number of serum giving animals.

Further, foot and mouth disease, which is always enzootic in the Bhotia villages, made its appearance amongst the control and serum giving animals by

the middle of October, 1902, the period of the year when the Bhotias bring their animals from summer quarters to the plains. This occurrence hampered the serum output to a certain extent and it was for this reason that the advisability of having a segregation kraal was brought before Government and has since been sanctioned.

It is, however, satisfactory to note that by working two small centrifugal machines for from 8 to 10 hours a day at their full velocity and also by the result of raising the protective values of weak sera, an increase of 40·4 per cent. in the output of serum has been made.

54. The following results have been collected from the reports received at this office concerning the serum injections and inoculations carried out in Bengal, Punjab, United Provinces, Assam, and Burma. The reports of other officers, who indented for serum as detailed in Appendix I, have not been received, although it was requested in this office letter No. 753, dated 6th October, 1902, through the Inspector-General, Civil Veterinary Department, that a summary of all field inoculations carried out with the serum prepared at Muktesar should be supplied to me from time to time, in order that a resumé of the results obtained might be included in the Annual Report.

55. *Bengal.*—

Injections with Serum alone.

District.	Number of villages of which cattle inoculated.	Number of cattle inoculated.	Date or period of inoculation.	Number of inoculated cattle died.	Remarks.
Khulna	10	1,419	July and August, 1902	2	
Midnapur . . .	10	1,332	August, 1902, to January, 1903.	7	
Muzaffarpore * . .	1	420	August, 1902 . .	1	* The people admired the action.
Chittagong † . . .	42	3,501	August, 1902, to March, 1903.	25	† (In an outbreak during August and September, 1902, out of 5 deaths 3 occurred 2 days after inoculation, as the outbreak was severe then.)
Champaran . . .	5	621	September, October, and December, 1902.	...	
24-Parganas . . .	6	473	September and October, 1902, and January to March, 1903.	4	
Backergunge . . .	10	1,037	September to November, 1902.	...	
Cooch Behar State . .	7	448	October and December, 1902, and January, 1903.	4	
Rajshai	3	293	September, 1902, and January, 1903.	16	
Mymensingh . . .	9	89	September and December, 1902.	13	
Purdwan . . .	1	34	September, 1902 .	3	
Howrah . . .	4	219	December, 1902, and January and February, 1903.	17	
Darbhanga . . .	2	156	December, 1902 .	...	
Jalpaiguri . . .	1	78	Ditto . .	16	
Calcutta . . .	1	70	Ditto . .	4	
Total .	112	10,190		112	Death rate 1·09 per cent.

On reference to the above table abstracted from the Bengal statistics submitted, it may be observed that the cattle belonging to the inhabitants of 112 villages 10,190 in number, were treated by the "serum alone method." Of this number 112 animals succumbed after injection, being a mortality of 1·09 per cent. Out of 15 districts and in 112 villages in which cattle were injected

by the "serum alone method," in 17 villages 1,814 were injected without a death occurring from rinderpest. No information, however, is on record which would indicate whether these latter injections were performed in the absence of rinderpest and as a precautionary measure only.

One may mention that the total deaths, *viz.*,—112 in 10,190 animals injected with serum, instead of being an argument against the utility of the protective serum, is strongly in favour of the good work accomplished by it, for in any outbreak of the disease whatever moment may be selected for the injection of the animals, a certain number must always have the *contagium* of the disease incubating in their systems.

56. *Punjab.*—

Injections with Serum alone.

District.	Number of villages of which cattle inoculated.	Number of cattle inoculated.	Date or period of inoculation.	Number of inoculated cattle died.	Remarks.
Lahore . .	28	7,763	October and December, 1902, and January to March, 1903.	2	
Umballa . .	3	100	October, 1902 . . .	...	
Rawalpindi .	44	4,204	October to December, 1902, and March, 1903.	...	
Gujranwala .	3	770	December, 1902, and January, 1903.	2	
Firozepore . .	40	10,476 *	December, 1902, to March, 1903,	...	* 2,995 goats.
Sialkote . .	8	532 †	March, 1903 . . .	...	† 125 „
Gurdaspur .	1	16	Ditto	...	
Total .	127	23,861		4	Death rate 0·0019 per cent.

Of 23,861 animals including 3,120 goats belonging to 127 villages, a mortality of 4 or 0·0019 per cent. is recorded in 20,741 cattle against no deaths in goats.

57. As no information is recorded as to whether all the animals affected with rinderpest or otherwise, were treated with the protective serum it is only natural to suppose that the injections of serum in the Punjab were only carried out in the animals of the herd which presented at the time of the operation no symptoms of the disease. Even then out of so vast a number as over twenty thousand it is difficult to imagine that only 4 animals or 0·0019 per cent. should have had in their systems the *contagium* of rinderpest, after having been exposed to the infected herd. The above mentioned casualties would point to the cattle of the Punjab being the possessors of a high degree of natural or acquired immunity.

58. *United Provinces of Agra and Oudh.*—

Injections with Serum alone.

District.	Number of villages of which cattle inoculated.	Number of cattle inoculated.	Date or period of inoculation.	Number of inoculated cattle died.	Remarks.
Partabgarh . .	1	8	December, 1902 . . .	...	
Kheri . .	7	404	December, 1902, and March, 1903.	...	
Gorakhpur * .	15	814	February and March, 1903 .	2	(One animal had the disease at time of inoculation.)
Dehra Dun . .	1	127	March, 1903	...	
Total .	24	1,353		2	Death rate 0·015 per cent.

* (*Before inoculation*, out of 412 cattle affected, 147 died at 35·6 per cent. and 265 recovered at 64·4 per cent.
After inoculation, 36 *uninoculated* cattle were affected and 16 died at 44·4 per cent.

In the abstract of particulars regarding injections of 1,353 head of cattle in 24 villages belonging to four districts of the United Provinces a mortality of 2 only, or 0·015 per cent. is recorded and of the two animals which succumbed, the disease was recognised in a mild form at the time the injection was made.

59. *Assam.*—

Inoculated by Simultaneous Method.

District.	Number of villages of which cattle inoculated.	Number of cattle inoculated.	Number of cattle recovered.	Date or period of inoculation.	Number of inoculated cattle died.	Remarks.
Shillong (Hill cattle.)	...	289	259 25	August and September, 1902.	5	Thirty developed rinderpest, gave second injections to 28 out of which 5 died.
Sibsagar	2	385	385	September, 1902	...	.....
Ditto	7	1,063	1,060	January and February, 1903.	3	Inoculation in 4 tea gardens, 788 cattle, and in 3 villages 275.
Total	9	1,737	1,729		8	

According to the returns submitted to th is office, it would appear that 1,737 head of cattle, hill and plains breeds we re inoculated by the simultaneous method, *viz.*, protective serum on one side of the body and virulent blood on the other. Of this number 1,729 recovered while 8 succumbed to the effects of inoculation.

In this instance 1,729 animals will have received an active immunity which should persist for a period of several years.

60. *Burma.*—

Injections with Serum alone.

District.	Number of villages of which cattle inoculated.	Number of cattle inoculated.	Date or period of inoculation.	Number of inoculated cattle died.	Remarks.
Toungoo	5	136	February, 1903	...	
Magwe	35	1,547	March, 1903	...	
Kyauksi	44	2,323	Ditto	...	
	84	4,006		...	

From the above table it would appear that no deaths occurred in 4,006 head of cattle injected with serum alone in 84 villages. The remarks stated in paragraph 57 of this report, with regard to the serum injections in the Punjab being carried out in the animals of the herd which presented no symptoms of the disease at the time of operation, apply *mutatis mutandis* to the Burma injections.

61. What will be the ultimate result or outcome of repeated injunctions of protective serum by the serum alone method, if the cattle so injected are not allowed to intermingle with the diseased portion of the herd immediately after the injection of serum, in order that they may, if possible, contract and pass through a modified form of the disease?

There may be a difference of opinion, but if the inoculated animals are separated and thus kept free from infection, it is possible that the ultimate effect may be to weaken the hereditary immunity to the disease which many breeds undoubtedly possess. It seems advisable, therefore, to issue instructions that where the serum alone method is employed, all injected animals should have immediate access to the infected portion of the herd.

62. *Results of Serum experiments.*—The researches carried out during the year under report with three samples of various sera deposited respectively in Meerut, Muktesar and Quetta, with a view to determine whether and to what extent they deteriorated in protective value when exposed to the maximum shade tempertaures recorded at each of the above mentioned stations show the following results:—

At Meerut.—When exposed for a period of 26 months including two hot seasons, maximum shade temperature rising to 107·7° F., it lost 55 per cent. of its protective power.

At Quetta.—When exposed for a period of 9½ months in the office of the Superintendent, Civil Veterinary Department, maximum temperature 98·6° F., the serum was found to have deteriorated, a dose of 7 c.c. being required instead of 5 c.c. per 600 lbs. body weight. A comparison will have to be instituted as to the protective value of No. XII serum, kept at the Muktesar temperature with that above recorded.

At Muktesar.—It was proved that the protective value had remained unaltered, which is a further proof that sera may be kept at a temperature of Muktesar (maximum shade 87·07° F.) without undergoing deterioration as a result.

63. *Anthrax.*—At the commencement of the year under report there was a balance in hand of 6·774 c. c. of Anthrax protective serum, while during the year 14·005 c. c. were prepared. The amount, *viz.*, 20,379 c. c. equivalent to 3·094 doses, was issued as shown in Appendix No. II.

64. *Serum inoculations against Anthrax in Madras.*

District.	Number of villages of which cattle inoculated.	Number of cattle inoculated.	Date or period of inoculation.	Number of inoculated cattle died.	Remarks.
Nellur . .	1	51	29th September to 7th October, 1902.	...	
Kishna . .	2	66	3rd to 19th October, 1902 .	...	
Tinnevelly . .	2	203*	15th to 20th December, 1902 .	1	
Ditto . .	1	57	27th to 29th November, 1902 .	...	
Total .	6	377		1	

* (Also one was inoculated with only 4 c. c.—(*i.e.*) 1 c. c. less—owing to want of serum.)

The Superintendent, Civil Veterinary Department, Madras, injected 377 head of cattle belonging to 6 villages and 1 animal or 0·26 per cent. succumbed.

65. With regard to the results, the following abstract is from the above mentioned officer's report, No. 750, dated 7th October, 1902, to the address of the Board of Revenue, Madras:—

"Care was taken to verify the disease by *post-mortem* examinations of the carcasses of animals which had recently died of the disease. Considerable difficulty was experienced at first in overcoming the objections of the cattle owners to inoculations, but the persuasions of a Brahman Veterinary Assistant ultimtely succeeded in calming their fears. After inoculation the animals were allowed to go out to graize or work as they had always been accustomed, and as they suffered no ill-effects from the operation the cattle owners of the surrounding villages were most anxious to have their herds also submitted to protective inoculations.

"The animals inoculated had all been in close proximity to animals which had recently died of Anthrax and, if none of these animals die of this disease during the next year, much confidence will be placed in the protective powers of the operation by the conservative cattle owners. If no harassing restrictions are imposed on the cattle such as compelling them to be isolated and tied up, I feel confident that preventive inoculation will become popular."

66. *Punjab.*—Abstract of the statements submitted by the Veterinary Superintendent of the Provincial Circle, Punjab, showing the results of inoculations performed with Anthrax protective serum may be seen in Appendix No. III. Of 8,413 animals, the property of the people residing in 50 villages, 244 were attacked with Anthrax and 203 or 83·19 per cent. succumbed to the disease previous to injection of serum.

Two thousand nine hundred and fifty-eight (2,958) animals, including cattle, 58 goats and nine ponies were injected with the above serum, only 5 animals, all bovines, one of which was reported to be suffering at the time of injection were attacked by the disease after the operation, and of this number 4 succumbed.

67. On reference to paragraph 17 it will be seen that during the epizootic of what was considered to be Anthrax in the Punjab, specimens were asked

for from typical cases and were secured and forwarded to me for examination. The specimens submitted were in each instance found to contain the organism of Barbone or Hæmorrhagic Septicæmia in virulent form and no other pathogenic organism—consequently it was concluded that the epizootic which occurred in the Punjab was principally, if not entirely, one of Hæmorrhagic Septicæmia. Later it was proved that anthrax protective serum in doses of 200 c. c. conferred no protection against Hæmorrhagic Septicæmia in bovines and buffaloes. While referring to Appendix III, it may be asked why there appeared to be a more or less sudden cessation of the epizootic when anthrax protective serum was injected into animals susceptible to the disease. The answer to this is that the great peculiarity of Barbone or Hæmorrhagic Septicæmia is that it attacks the animals of a certain village but seldom or ever remains in that particular locality for a period exceeding 9 to 10 days. This is exactly the opposite in the case of Anthrax, where the locality always remains an infected area. Therefore, it will be easily understood that any other serum utilized after the cessation of Hæmorrhagic Septicæmia epizootic in any particular locality would have probably had what appeared to be an equally beneficial effect.

68. *Hæmorrhagic Septicæmia, (Ghotwa, Ghotu) or Malignant-sore-throat.*—The following results were arrived at during the rains of 1902 :—

(i) Cattle exposed to natural infection shut up with diseased and dying animals of the same species for a period of 14 to 21 days, do not contract the disease in an acute form, when allowed to lick the saliva and other body fluids if no abrasions of the mouth or body exist. They pass through an almost imperceptibly mild attack of the disease, as evidenced by a slight rise in temperature only. The same cattle when subcutaneously inoculated at a later date, with a virulent culture of Hæmorrhagic Septicæmia showed no reaction and were therefore protected, although the Control succumbed within the usual period.

(ii) No immunity against Hæmorrhagic Septicæmia is conferred upon plains cattle when hyperimmunized against rinderpest.

(iii) Bovines which have passed through an attack of foot and mouth disease are just as susceptible to the inoculated virus of Hæmorrhagic Septicæmia as healthy bovines.

(iv) Plains bovines injected intravenously with anthrax protective serum receive no protection therefrom against inoculated Hæmorrhagic Septicæmia.

(v) Bovines injected on *two* or *more* occasions with bile derived from cattle which have succumbed to Hæmorrhagic Septicæmia, the bile utilized for subcutaneous injection in the first instance containing the organism of the disease in a less virulent form than that contained in the fluids subsequently used, will be found after an interval of 10 days from the last injection to be respectively protected against a dose of 0·1 to 0·2 c.c. of a virulent culture.

(vi) Animals which proved refractory to inoculated virulent cultures of the Hæmorrhagic Septicæmia, *viz.*, ponies, sheep, goats, and protected bovines and buffaloes when subsequently injected for long period with successive increasing doses of such cultures, furnished powerful protective sera against Hæmorrhagic Septicæmia.

69. *Material examined.*—Numerous cover glass preparations of pus and blood together with samples of blood sealed in glass pipettes supplied for the purpose have been received during the year for examination and report. Among the above were Lymphangitis Epizootica (100 specimens)—Pueperal Septicæmia in the elephant, and specimens of elephants' blood which indicated death from the nematode "uncinnarria os papiliatum" lately described by Professor Ostertag as occurring solely in the Indian elephants.

70. *Other diseases.*—The six diseases under observation during 1902-03 were :—(i) Rinderpest, (ii) Rinderpest in plains bovines immediately followed by spontaneous Hæmoglobunaria or Texas Fever, (iii) Anthrax, (iv) Barbone in buffaloes or Hæmorrhagic Septicæmia, all of which have been treated of in their respective places. But a very large amount of research work has also

been carried on and will be continued during the ensuing year with regard to other diseases with the material we have at our disposal, *viz.* :—

(i) Surra in camels,
(ii) Dourine in equines,
(iii) Tubercle in bovines.

Reference has been made to the line which the above researches are likely to follow, and when definite results have been obtained the application of these results will be submitted in full, concerning each individual disease.

Section III.

Administration.

71. During the year under review the charge of the Laboratory was held by me, and Veterinary-Captain J. D. E. Holmes occupied the post of the Assistant Bacteriologist throughout the year.

72. As in previous years, the major portion of the officers' time was occupied in preparing rinderpest and anthrax sera, while in addition, exhaustive investigations were carried on into the intimate etiology of Barbone, a disease of buffaloes more commonly known as Hæmorrhagic Septicæmia, with a view to discover the best method of preparing a protective serum and other modes of conferring immunity against this disease to buffaloes and cattle generally.

Further, test experiments were continued throughout the year to determine the protective power of all sera prepared at this Laboratory, and according to the expressed wish of the Government serum testing experiments on different breeds of cattle were continued during the cold season at the branch depôt at Bareilly, where animals were obtained from the Lucknow, Jalaun, and Meerut districts.

73. *Mallein.*—During the past year, 608 doses of English and French Mallein have been issued from the Laboratory to the Superintendents of the Civil Veterinary Department as shown in Appendix IV. The above number includes 52 doses of English Mallein supplied to the Veterinary Inspector, Srinagar, Cashmere.

74. *Bareilly Branch Depôt.*—As anticipated in last year's report, the main Laboratory building and other out-houses were ready for occupation during the past cold weather. The first and the most important work to be taken in hand was to place the depôt in working order, for much had to be accomplished before the investigation of any disease could be undertaken. With the above end in view, and on obtaining the permission of the Government, I with the necessary staff proceeded to Bareilly on 17th November, 1902, arranging for the work of serum preparation, its despatch and test, etc., to be carried on at Muktesar, under the supervision of the Assistant Bacteriologist. The purchase of the necessary fittings and furniture were effected as far as the funds set aside for the purpose permitted of. The chemicals and apparatus sanctioned for the Depôt were received in the month of January, 1903, and as the centrifuge and oil engine were expected to arrive by the end of March, a request was made to the Public Works Department authorities to take the buildings in hand in anticipation of sanction to final plans and estimates. These buildings were put in hand in December and were erected by the end of March. They are now in a condition to receive the machinery, and information has within the past few days been received that the goods have arrived in Bombay.

75. During the 4½ months sojourn in the branch depôt, the following subjects were under investigation:—

(1) Serum testing experiments on different breeds of cattle.
(2) Hæmoglobunaria or Texas fever which appeared spontaneously in the cattle under observation.
(3) Surra in camels obtained from Bikaner and Ajmere.
(4) Dourine in Arabs, English and country-bred horses and mares.
(5) Hæmorrhagic Septicæmia in donkeys.

The advantages of the small depôt in the plains have been fully demonstrated during the first cold season's work, for investigations into the etiology of

several different diseases have been entered upon which would have been next to impossible to conduct in the central Laboratory in the hills.

Further, under the scheme for the training of Veterinary Assistants, arrangements had been made to give instructions to 20 assistants each month. During the year under report two courses were held at Bareilly, but only 27 Veterinary Assistants presented themselves for training, probably owing to the Delhi Durbar and the post-graduate course held at Lahore.

76. *Fodder Supply.*—The arrangements for the supply of fodder at Muktesar remained the same as during the past year. The collection of grass was made from the neighbouring forests up to the radius of 8 to 10 miles from the Laboratory. In addition, a considerable amount of fodder was obtained from areas placed under cultivation in the Nursery Garden and the Laboratory forest. The work of opening up fresh ground for the ultimate production of grass and fodder has been continued and it is hoped that this year a material increase in the supply of fodder in one form or another may be forthcoming.

77. *Forest.*—The arrangements for managing the Laboratory forest were satisfactory and it was successfully protected against fire. No illicit fellings or other damages were reported. The blank spaces planted with young Deodars and others sown with oak in previous years did not shew promising results, for the majority of the former died and the latter failed to germinate. During the past rainy season a small area in compartment No. 14 was planted with Deodar on the higher ground, while oak was sown *in situ* on the lower elevations of the same compartment, following the directions as laid down in paragraph 50 of the Working Plan for the Muktesar Reserved Forest. The natural reproduction of trees in blank spaces fit for planting, free from the grazing rights of villagers, is establishing itself and making good progress. During the year under review, arrangements were made with the Deputy Commissioner, Almora, for the utilization of surplus material available to be converted into charcoal and from this source a royalty of R119-5-3 was collected.

78. *Meteorological Observations.*—These observations have been continued as in previous years. The daily temperatures, barometric pressures, rain, directions of wind and its velocity, etc., have been recorded three times daily, and a copy of the same has been supplied monthly to the Meteorological Department for record and reference.

79. *Buildings.*—The main Laboratory building is not yet quite complete, most of the rooms that were ready have been occupied, but something remains to be done with regard to the fitting and furnishing of some of the rooms. Under the scheme sanctioned for the enlargement of the Imperial Bacteriological Laboratory, no progress has been made up to the present with regard to the construction of the required buildings, but recently the cutting and clearing of a site for the engine shed has been taken in hand. The administrative sanction of Government to the above buildings was accorded in January last and it is not known from what cause the delay in actual construction has occurred.

80. *Training of Veterinary Assistants.*—During the year under report one hundred and seven (107) Veterinary Assistants and graduates were trained at Muktesar and Bareilly Laboratories and all passed. Of this number, Bengal sent 21, United Provinces 32, Punjab 29, Baluchistan and North Western Frontier Districts 4, Bombay and Sindh 5, Berar and Central Provinces 10, Native States 3, and for Malay State 2. The course of instruction was the same as in the last year and in each instance it lasted for a period of one month.

81. *Staff and Establishment.*—A second European Laboratory Assistant Mr. David Keiller was added to the staff during the month of November. Being quite inexperienced as to the work carried on in large research Laboratories he will be but of little value for some time to come as he will have to be trained *ab initio.*

It again gives me pleasure to be able to put on record my appreciation of the hearty co-operation I received from the staff and establishment, which entailed continuous work on Sundays and leave days.

ALFRED LINGARD, M.B., M.S., D.P.H., etc.,

The 27th May 1903.

Imperial Bacteriologist.

APPENDIX I.

Table showing the amount of Anti-Rinderpest Serum manufactured and despatched during the year 1902-1903.

Amount Manufactured.		Amount Issued.		Remarks.
Stock.	c. c.	Abstract of issue.	c. c.	
Balance in hand from 1901-1902.	251,847	Issued as per detail below . . .	539,600	
Manufactured during 1902-1903.	473,471	Utilized in experiments at Muktesar and Bareilly.	14,049	
		Tested serum in hand	120,450	Equals to 23,751 doses.
		Untested ditto	51,219	„ „ 5,121 „ (approximately).
Total .	725,318	Total .	725,318	

Issue.

Serial No.	Date of issue.	To whom consigned.	No. of cubic centi-metres.	No. of doses calculated for plains animals per 600 lbs. Body weight by simulta-neous method.	Labora-tory No. of serum.	Standard.
						c c.
1	1st April 1902 .	The Chief Supply, Transport Officer, Peshawar.	4,200	381	XIII	11
2	28th May 1902 .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	5,600	1,120	XII	5
3	5th June 1902 .	The Superintendent, Civil Veterinary Department, Bengal, care of Veterinary Assistant Paul, Bankipur.	5,600	1,120	„	5
4	13th ditto .	Ditto ditto .	5,600	1,120	„	5
5	Ditto .	The Commissioner of Coorg . .	700	140	„	5
6	18th ditto .	S. K. Mittar, c/o of Mr. Apperby, Segowlie.	10,500	2,100	„	5
7	2nd July 1902 .	Rai Bahadur Daulat Ram, C.I.E., Kalka.	750	150	„	5
8	Ditto .	The Superintendent, Civil Veterinary Department, Madras, Chepauk.	5,600	1,120	„	5
9	3rd ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	5,600	1,120	„	5
10	15th ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	5,600	1,120	„	5
11	18th ditto .	Ditto ditto .	5,600	1,120	„	5
12	20th ditto .	The Superintendent, Civil Veterinary Department, Baluchistan and Sind, Quetta.	2,800	560	„	5
13	25th ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	10,500	2,100	„	5
14	31st ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	25,200	5,040	„	5
15	Ditto .	The Superintendent, Civil Veterinary Department, Burma, Rangoon.	20,300	4,060	„	5

Issue—continued

Serial No.	Date of issue.	To whom consigned.	No. of cubic centimetres.	No. of doses calculated for plains animals per 600 lbs. Body weight by simultaneous method.	Laboratory No. of serum.	Standard.
						c. c.
16	12th August 1902 .	Veterinary Assistant Murid Hussain, Jwalapur, Oudh and Rohilkhand railway.	2,100	210	XIV	10
17	15th ditto .	Pt. Tek Chand, Circle I, Veterinary Inspector, Babugarh.	1,400	140	„	10
18	Ditto .	Sheikh Hussain Bux, Circle III, Veterinary Inspector, Allahabad.	2,800	280	„	10
19	21st ditto .	Mr. B. Basu, G. B. V. C., Sibsagar, Gauhati, Assam.	50,050	5,005	„	10
20	30th ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	30,100	3,010	„	10
21	12th September 1902	Sheikh Amir Ahmed, Circle II, Veterinary Inspector, Lucknow.	700	140	XII	5
22	13th ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	30,100	3,010	XIV	10
23	29th ditto .	The President, District Local Board, Karachi.	700	140	XII	5
24	25th October 1902 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	18,200	3,033	XV	6
25	29th ditto .	The Chairman, District Board, Bulandshahr.	700	140	XII	5
26	Ditto .	The Chairman, District Board, Aligarh	700	116	XV	6
27	Ditto .	Ditto ditto Fatehpur	700	140	XII	5
28	Ditto .	Ditto ditto Hamirpur	900	150	XV	6
29	7th November 1902	The Superintendent, Civil Veterinary Department, Central Provinces, Nagpur.	3,150	315	XIV	10
30	24th ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	18,200	3,033	XV	6
31	29th ditto .	Amir Ahmad, Veterinary Inspector, District Kheri.	1,750	175	XIV	10
32	30th ditto .	Mr. S. Stockman, C. V. D., Khandwa.	700	70	XI	10
33	4th December 1902	The Chairman, District Board, Sultanpur.	1,050	175	XV	6
34	5th ditto .	Ditto Moradabad	1,050	175	„	6
35	Ditto .	Ditto Kheri	1,050	175	„	6
36	Ditto .	Ditto Barabanki	1,050	175	„	6
37	Ditto .	Ditto Sitapur	1,050	175	„	6
38	Ditto .	Ditto Banda	1,050	175	„	6
39	10th ditto .	The Superintendent Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	12,250	2,041	„	6
40	23rd ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	18,200	3,033	„	6
41	29th ditto .	Ditto ditto .	18,200	3,033	„	6
42	31st ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	12,250	2,041	„	6
43	Ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Muktesar, Ferozepur.	30,100	5,016	„	6

Issue—concluded.

Serial No.	Date of issue.	To whom consigned.	No. of cubic-centimetres.	No. of doses calculated for plains animals per 600 lbs. Body weight by simultaneous method.	Laboratory No. of serum.	Standard.
						c. c.
44	3rd February 1903 .	The Assistant to Inspector General, Civil Veterinary Department, Meerut.	6,300	1,050	XV	6
45	5th ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	12,250	2,041	„	6
46	14th ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	18,200	3,033	„	6
47	13th ditto .	The Assistant to Inspector General, Civil Veterinary Department, Gorakhpur.	6,300	1,050	„	6
48	18th ditto .	Veterinary Assistant Ghulam Hussain, Veterinary Dispensary, Ferozepur.	15,050	1,505	XIV	10
49	21st ditto .	Ditto ditto .	7,700	1,540	XVI	5
50	20th ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	15,400	3,080	„	5
51	21st ditto .	Veterinary Assistant Ganga Ram, Palampore, *vid* Pathankote.	5,250	1,050	„	5
52	Ditto .	The Superintendent, Civil Veterinary Department, Madras.	2,800	560	„	5
53	24th ditto .	Veterinary Assistant Mohamed Yasin, Pathankote, Punjab.	5,250	1,050	„	5
54	3rd March 1903 .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	25,200	5,040	„	5
55	Ditto .	The Superintendent, Civil Veterinary Department, Burma, Rangoon.	30,100	6,020	„	5
56	24th ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	15,400	3,080	„	5
		Total .	539,600	87,791		

ALFRED LINGARD
Imperial Bacteriologist.

APPENDIX II.

Table showing the amount of Anthrax Serum despatched during the year 1902-1903.

Serial No.	Date of issue.	To whom consigned.	No of cubic centimetres.	No. of doses.	Standard.
1	18th July 1902 .	Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	2,500	500	c. c. 5 per animal.
2	1st August 1902 .	Ditto ditto .	725	145	5 ditto.
3	12th ditto .	Ditto ditto .	3,550	355	10 ditto.
4	21st ditto .	Mr. B. Basu, G.B.V.C., Sibsagar, Assam.	2,000	200	10 ditto.
5	26th ditto .	Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	1,130	113	10 ditto.

Table showing the amount of Anthrax Serum despatched during the year 1902-1903—contd.

Serial No.	Date of issue.	To whom consigned.	No. of cubic centimetres.	No. of doses.	Standard.
6	9th September 1902	Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	800	160	c.c. 5 per animal.
7	10th ditto .	Superintendent, Civil Veterinary Department, Madras, Chepauk.	700	70	10 ditto.
8	24th ditto .	Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	2,020	404	5 ditto.
9	27th ditto .	Ditto ditto .	1,700	340	5 ditto.
		Ditto ditto .	1,730	173	10 ditto.
10	17th October 1902 .	Ditto ditto .	600	120	5 ditto.
11	18th ditto .	Superintendent, Civil Veterinary Department, Madras, Chepauk.	300	60	5 ditto.
12	3rd December 1902 .	Ditto ditto .	1,020	204	5 ditto.
13	19th February 1903 .	Ditto ditto .	1,250	250	5 ditto.
		Note—Utilized in experiments at Muktesar.	354	...	...
		Total .	20,379	3,094	...

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX III.

Table showing the results of inoculations performed with Anthrax protective Serum.

District.	No. of villages.	Date of outbreak.	No. of Cattle in village.	Before inoculation. Attacked.	Died.	Mortality. per cent.	Date of inoculation.	No. of Cattle inoculated.	After inoculation. Attacked.	Died.	Remarks.
Lahore .	1	3rd January 1902 .	735	30	5	16·6	14th January 1902 .	6	...	...	
Ditto	4	Figures not forthcoming					24th September to 12th October 1902.	815	1	1	
Sialkot .	1	1st March 1902 .	1,200	25	24	96·0	15th March 1902 .	21	...	...	
Ditto .	4	Figures not forthcoming					18th and 19th September 1902.	150	...	...	
Ditto .	1	Ditto	ditto		ditto		6th to 8th October 1902.	2	...	...	
Ditto .	1	Ditto	ditto		ditto		6th to 9th October 1902.	7*	...	...	*Ponies.
Ditto .	2	Ditto	ditto		ditto		18th September 1902	2†	...	...	†Ponies.
Jhelum .	5	1st to 16th July 1902.	942	59	47	79·0	18th July to 6th August 1902.	628	1	...	
Ditto .	1	Figures not forthcoming					20th to 22nd September 1902.	130	2	2	
Ditto .	1	Ditto	ditto		ditto		23rd to 29th September 1902.	40	...	...	
Kangra .	1	15th July 1902 .	490	15	15	100·0	3rd August 1902 .	130	...	...	(58 goats.)
Ditto .	1	Figures not forthcoming					20th and 21st October 1902.	74	...	...	
Umballa .	3	10th and 11th July 1902.	814	7	7	100·0	6th to 8th August 1902.	16	...	...	
Ferozepore .	12	10th to 15th August 1902.	1,145	63	62	98·4	17th to 24th August 1902.	425	...	...	
Ditto .	1	Figures not forthcoming					28th September 1902	13	...	...	
Jallundhur .	2	9th August and 1st September 1902.	1,355	32	30	93·7	16th August and 6th September 1902.	132	...	...	

Table showing the results of inoculations performed with Anthrax protective Serum—contd.

District.	No. of villages.	Date of outbreak.	No. of Cattle in village.	Before inoculation.			Date of inoculation.	No. of Cattle inoculated.	After inoculation.		Remarks.
				Attacked.	Died.	Mortality. per cent.			Attached.	Died.	
Jallundhur .	1	Figures not forthcoming					6th to 17th September 1902.	96	...	...	
Ditto .	1	Ditto ditto			ditto		27th September to 8th October 1902.	75	1	1	
Hoshiarpur .	1	Ditto ditto			ditto		2nd and 3rd September 1902.	48	...	...	
Ditto .	1	20th August 1902 .	1,732	13	13	100·0	3rd September 1902 .	48	...	...	
Gujranwala .	5	Figures not forthcoming					8th to 18th September 1902.	100	...	...	
Total .	50	...	8,413	244	203	83·19		2,958	5	4	

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX IV.

Table showing the number of doses of English and French Mallein issued from the Imperial Bacteriological Laboratory during 1902-1903.

Serial No.	Date.	To whom issued.	No. of Doses.	
			English.	French.
1	30th April 1902 .	The Superintendent, Civil Veterinary Department, North Punjab, Srinagar, Kashmir.	12	...
2	5th May 1902 .	Ditto ditto .	24	...
3	6th ditto .	The Superintendent, Government Farm, Hissar .	...	100
4	19th June 1902 .	The Superintendent, Civil Veterinary Department, North Punjab, Srinagar, Kashmir.	12	...
5	28th ditto .	The Veterinary Inspector, Srinagar Kashmir . .	12	...
6	1st July 1902 .	Ditto ditto .	12	...
7	21st ditto .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	25	25
8	4th August 1902 .	K. Hewlett, Esq., C. V. D., Rawalpindi . . .	14	6
9	8th ditto .	The Veterinary Inspector, Srinagar, Kashmir . .	4	...
10	22nd September 1902	Ditto ditto .	24	...
11	Ditto .	The Superintendent, Civil Veterinary Department, North Punjab, Rawalpindi.	12	...
12	1st November 1902 .	Ditto ditto .	100	100
13	13th ditto .	The Superintendent, Civil Veterinary Department, Provincial Circle, Punjab, Lahore.	10	...
14	14th ditto .	The Superintendent, Civil Veterinary Department, Central Provinces, Nagpur.	4	...
15	24th December 1902.	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	...	50
16	26th January 1903 .	The Superintendent, Government Farm, Hissar .	50	...
17	26th March 1903 .	The Superintendent, Civil Veterinary Department, North Punjab, Abbottabad.	12	...
		Total .	327	281

ALFRED LINGARD,
Imperial Bacteriologist.

XIX.—IMPERIAL.

Table showing main results of working of the Imperial Bacteriological Laboratory during 1902-1903.

	I QUANTITY OF SERUM OR ANTI-TOXIN PREPARED AND ISSUED.								II PRACTICAL INSTRUCTION IN INOCULATION.			III FINANCIAL RESULTS.																	
	Rinderpest Serum. 1			Anthrax Serum. 2			3	4				Receipts.				Expenditure.												
	Prepared.	Issued.	Stock in hand.	Prepared.	Issued.	Stock in hand.			Province.	No. of Veterinary Inspectors or Assistants sent to the Laboratory.	No. who passed.	Sale of animals.	Sale of garden products and Revenue from Reserved Forest.	Other miscellaneous receipts.	Total.	Salaries and travelling allowance of officers and subordinate establishments.	Feed and keep of animals.	Purchase of animals.	Cost of chemicals and apparatus.	Other miscellaneous expenditure.	Total.								
	c. c.	c. c.	c. c.	c. c.	c. c.	c. c.						R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.								
Muktesar Laboratory.	Opening balance 251,847			Opening balance 6,774					Bengal	21	21																	
	Prepared during 1902-1903 473,471			Prepared during 1902-1903 14,005					United Provinces	14	14																	
									Punjab	23	23																	
									North-West Frontier Districts.	1	1																	
									Baluchistan	2	2																	
		553,649*	171,669†		20,379	400			Sindh	2	2	410 13 0	502 12 3	199 12 0‡	1,113 5 3	33,085 2 1	10,142 6 8	6,200 0 0	23,357 15 6	4,819 11 2	79,705 3 5							
									Bombay	3	3																	
									Berar	1	1																	
									Central Provinces	8	8																	
									Native States	3	3																	
									For Malay States	2	2																	
Bareilly Depôt									United Provinces	18	18																	
									Punjab	6	6																	
									North-West Frontier Districts.	1	1	243 14 9	128 0 0	18 4 0	490 2 9	8,915 14 8	1,553 13 10	2,139 4 9	§7,378 12 0	663 11 2	20,646							
									Central Provinces	2	2																	
	725,318	553,649	171,669	20,779	20,379	400	...	...	...	107	107	754 11 9	630 12 3	218 0 0	1,603 8 0	42,001 0 4	11,696 4 6	10,439 4 9	30,731 11 6	5,483 6 4	100,351 11 5							

Machinery 17,619 9 0
Chemicals and apparatus. 4,490 6 0
Library . . 1,248 0 0

* Includes 14,049 c. c. utilized in experiments.

† This consists of 120,450 c. c. tested serum, equivalent to 23,751 doses, at 5 and c. c. per 600 lbs. body weight, simultaneous method.

‡ Cost of Mallein.

§ Cost of centrifugal machines, oil engine and apparatus.

ALFRED LINGARD,
Imperial Bacteriologist.

1903.

File No. 67 of 1903.

Serial No. 5.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

CIVIL VETERINARY ADMINISTRATION.

To

THE INSPECTOR GENERAL, CIVIL VETERINARY DEPARTMENT.

No. 1922—67-5.

Dated Simla, the 29th October 1903.

SUBJECT.

Annual Report of the Imperial Bacteriologist for the year 1902-03.

G. C. Press, Simla.—No. 931 R. & A. D.—31-10-03—270.—J. K.

No. 1922—67-5.

FROM

J. O. MILLER, ESQ., C.S.I.,
Secretary to the Government of India,

TO

THE INSPECTOR GENERAL, CIVIL VETERINARY DEPARTMENT.

Dept. of Rev. & Agri.
Civil Veterinary Administration.

Simla, the 29th October 1903.

SIR,

I AM directed to return the copy of the Report of the Imperial Bacteriologist for the year 1902-03 received with your letter No. 346-C., dated the 23rd July last, and to communicate the following remarks of the Government of India thereon.

2. The year has been one of considerable activity, and an increasing measure of success has attended the operations connected with inoculation against rinderpest. There has been a substantial increase in the quantity of serum manufactured and issued during the year, and the large demand for it is gratifying evidence of the growing popularity of inoculation. Dr. Lingard has in hand experiments connected with equine and other bovine diseases which promise to yield valuable results. I am to express the satisfaction of the Government of India with the work accomplished during the year by Dr. Lingard and his staff.

3. The report opens with a description of the experiments conducted during the year with regard to the immunity conferred by rinderpest bile and gives a detailed and very technical description of the results obtained. Such details are doubtless of the greatest interest to the scientific world, but they are of little use to the ordinary public, and are out of place in a purely Departmental Report which is intended merely to record the year's work in a simple and concise form. I am to request that the attention of the Imperial Bacteriologist may be drawn to the instructions conveyed in Mr. Arbuthnot's letter No. 862—49-1 of the 19th March 1901, and that he may be directed to adhere strictly to these orders in future by avoiding such purely technical details and confining himself to recording the actual results achieved.

4. The experiments to test the effect of temperature on the protective power of rinderpest serum are interesting and appear to have proved conclusively the fact that exposure to a high temperature has a destructive effect in the prophylactic value of the serum. I am to suggest that the co-operation of Local Governments may be invited with a view to providing proper cool storage chambers at the various depôts. The experiments referred to in paragraphs 10 to 14 of the Report to ascertain the strength of doses of serum required to secure protection in different breeds of cattle should, in compliance with the orders conveyed in my letter No. 1058—63-4, dated the 25th June last, be printed separately for the information and guidance of Provincial Superintendents.

5. With reference to paragraph 61 of the report I am to say that the Government of India understand from your letter No. 159—277, dated 19th August 1903, that the attention of Civil Veterinary Officers has been called to the importance of allowing inoculated animals to mix freely with the infected herd.

6. The Report may now be printed off and distributed in accordance with the list forwarded with Mr. Arbuthnot's letter No. 1960—108-3, dated the 9th September 1902, a copy of this letter being included at the end of the Report.

I have the honour to be,

SIR,

Your most obedient Servant,

J. O. MILLER,

Secretary to the Government of India.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1905-1906.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA,
1906.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1905-1906.

SECTION I.

Administration.

No. 674, dated Muktesar, the 25th June 1906.

From—The Imperial Bacteriologist, Muktesar,

To—The Inspector General, Civil Veterinary Department, Simla.

I have the honour to submit my Annual Report for the past official year 1905-1906.

2. I remained in charge of the office of the Imperial Bacteriologist throughout the year. Mr. R. E. Montgomery held the office of the Assistant Bacteriologist up to the 7th December 1905, but remained in Muktesar, according to orders received, up to the end of December 1905, in order to initiate Mr. Martin in the duties of the Assistant Bacteriologist. Mr. G. D. Martin, M.R.C.V.S., was appointed by the Secretary of State for India to the Indian Civil Veterinary Department, and on arrival in India assumed the office of the Assistant Bacteriologist at Muktesar, with effect from the 8th December 1905.

3. As during the past years, the major portion of the officers' time was occupied in routine work and the preparation of Rinderpest, Anthrax, and Hæmorrhagic Septicæmia sera together with Mallein, in large quantities.

In addition, observations on cases of Dourine in equines and Surra in equines and camels, were continued, together with numerous experiments, with the object of destroying the respective trypanosomata by the administration of arsenic, trypan-rot, and both in combination, and by other methods also.

4. *Training of Veterinary Officers.*—In two courses at Muktesar, each one lasting two months, four officers of the Army Veterinary Department attended 60 lectures and daily practical classes during the months of June to September 1905. These officers were instructed in comparative pathology, bacteriology, and microscopical work, with special reference to the different diseases of animals met with in this country. They also received instruction in serum therapeutics and were taught bacteriological technique.

5. *Training of Veterinary Assistants.*—During the year under review, 37 Veterinary Assistants were trained at Muktesar and 24 at Bareilly, making a total of 61. The arrangements at Muktesar and Bareilly were effected to train, every month, 8 and 20 students respectively, but the Provincial Superintendents could not spare their subordinates to be detailed for training to the maximum number arranged for.

6. During the year, in addition to my other work, I published the following papers:—

(*i*) Through what agency is the Trypanosoma Evansi carried from one Surra season to another—published in the *Journal of Tropical Veterinary Science*, Vol. I, Part I,

(*ii*) A new species of Trypanosoma found in the blood of rats together with a new metrical method of standardizing the measurements of Trypanosomata—published in the *Journal of Tropical Veterinary Science*, Vol. I, Part I.

(*iii*) Ocular Filariæ of Equines and Bovines—published in the *Journal of Tropical Veterinary Science*, Vol. I, Part II.

(*iv*) Note on Hæmorrhagic Septicæmia.

7. *Fodder Supply.*—During the past year, the arrangements for grass supply were satisfactory. As in previous years, the grass was obtained from the Nursery Garden, cultivated areas, part of Reserved and Protected Forests of the Laboratory, and also by purchase at a distance of 8 miles from Muktesar.

The question of adding more land to the Laboratory estate for providing fodder, etc., for increased number of animals is still under the consideration of the Government of India, and it is hoped that favourable orders will soon be passed on the same.

All cultivated patches utilized for producing fodder at the Laboratory were measured during the year, so as to form a correct idea of the produce. The total area has been found to measure 105 acres, 1 rood and 31 poles. The subject of providing coolie labour from Doti (Nepal territory) was improved upon by framing easier rules for taking work from them at Muktesar, but the difficulties in securing the said labour were the same as in previous years.

8. *Forest.*—The administration of the Laboratory Forest was most satisfactory, as, no fires, illicit fellings or any other damage was reported during the past year.

Our Nurseries of Deodars have made good progress during the year and the plants are of sufficient size and strength to be transplanted during the coming season, in the coupe which has been under operation during the year.

9. *Meteorological Observations.*—The collection and record of these observations have been continued regularly three times daily as in previous years, and the statements submitted to the Meteorological Department.

10. *Buildings.*—The water-supply scheme has been completed and owing to the great increase in the quantities of the various sera prepared at Muktesar, Government sanctioned the removal of the 8 H. P. engine and centrifugal machine from Bareilly to the Central Laboratory. Some time, however, must elapse before both engines can be worked concurrently, for the present house has to be altered to give accommodation to the second engine and centrifugal apparatus. The utility of the Laboratory will be considerably enhanced when the plans and estimates of the extra buildings now in contemplation and those in course of construction are completed.

11. *Branch Laboratory at Bareilly.*—As usual, the work at Bareilly was commenced by the middle of November 1905. The observations on Dourine and equine Surra were continued and fresh cases of camel Surra were obtained with a view to further observations and experiments. As our previous observations had not afforded us any positive proof with regard to the susceptibility of various species of deer to disease and also as to their capabilities of carrying infection from one season to another, advantage was taken of initiating experiments on black buck with the causal factors of equine Surra and Rinderpest respectively.

In addition, experiments as to the destructive power of arsenic and trypanrot on the trypanosomata of Surra and Dourine respectively were continued. The training of Veterinary Assistants was as usual carried out during the winter months at the branch depôt. The winter class is much sought after by the students from Southern India and Bengal, as the climate of Bareilly is more congenial and acceptable than the intense cold experienced at that season at Muktesar.

12. *Staff and Establishment.*—During the year under review, one Observer and Despatcher, one Farm Jamadar for Ritani were sanctioned and entertained. The sanctioned posts of two Native Laboratory Assistants were also filled up after much difficulty.

The services of a Hospital Assistant to take charge of the Dispensary now under course of construction have been sanctioned and steps are now being taken to obtain such a subordinate. It may be noted that 2,024 different persons have been medically and surgically treated by me during the past five years. Many of the above patients attended on numerous occasions.

As in previous years, I received hearty co-operation from the staff and establishment in the discharge of the multifarious duties connected with the working of this Laboratory, which is ever on the increase.

Section II.

Research.

13. The work to be carried out during 1905-1906 was proposed on the following diseases being similar to the rough programme suggested for the last year:—

(i) Rinderpest,
(ii) Piroplasmosis, Trypanosomiasis and Malignant œdema, occurring as secondary diseases to rinderpest,
(iii) Anthrax,
(iv) Hæmorrhagic Septicæmia,
(v) Surra,
(vi) Charbon Symptomatique,
(vii) Dourine.

Rinderpest.

14. The following experiments were conducted with a view to determine the protective value of various anti-rinderpest sera, prepared by hyper-immunizing different breeds of cattle with virulent blood obtained from the same and from other breeds, after allowing periods varying from five and a half to six years to elapse, during which intervals the sera were deposited at Muktesar.

The results of the test experiments were as follows:—

(i) *Plains animal hyper-immunized with hill blood.*—The serum after being kept at Muktesar in the cold room, temperature varying between freezing point and a maximum of 67°F., during a period of six years was found to have lost 33·3 per cent. of its protective value, a dose of 45 c. c. being required to protect hill cattle per 600 lbs. body weight in 1906, instead of 30 c. c. found sufficient in 1900.

(ii) *Hill bull hyper-immunized with virulent hill blood.*—The resultant serum, preserved under similar conditions as those noted above, after a period of 5 years and 9 months, at Muktesar, was found to have retained its previous protective power of about 10 c. c. per 600 lbs. for hill cattle. It must be noted that a sample of this serum was tested in 1901, 13 months after its preparation, and it was then considered that the protective power was even greater than at the time of the primary testing on 16th July 1900.

(iii) *Buffalo hyper-immunized with virulent buffalo blood.*—The serum prepared from the first bleeding of this animal on the 9th May 1900, tested on hill cattle, gave a dose of 30 c. c. per 600 lbs.; it was retested on the 12th April 1906, after an interval of nearly six years, and found to have lost none of its original protective power on hill cattle when inoculated by the simultaneous method.

From the above experiments, it will be observed that of the various sera tested, those which were prepared by hyper-immunizing a certain breed with virulent blood from the same breed, after a period of six years, exhibited a higher protective power, than those hyper-immunized with virulent blood from another breed of animals.

The conclusions arrived at from the above observations are of peculiar scientific interest, but will, in no way, modify the preparation of anti-rinderpest serum from our chief source, *i.e.*, hill bulls, according to existing methods, *viz.*, plains animals hyper-immunized with virulent blood from hill bulls. The reason being that the serum is not retained for any length of time in the cold room at Muktesar, but is usually issued about as rapidly as it can be collected and tested.

15. *Serum experiments.*—Under the orders of the Inspector General, Civil Veterinary Department, the Superintendent, Civil Veterinary Department, Central Provinces, deposited a certain quantity of anti-rinderpest serum No. XXII in a pit in the ground at Nagpur for a period of a year, with a view to having it tested as to the loss of protective power or otherwise. At the termination of that period (October 1905) a sample bottle of 350 c. c. of the serum above referred to was forwarded to Muktesar from the Central Provinces, and, at a later date, was tested with the following result:—

Serum No. XXII deposited at Muktesar was tested on two different occasions:—

(i) At the time of preparation June 1904.
(ii) One and a half years later.

The protective power was found to be identical on each occasion.

The quantity of serum returned from Nagpur did not allow of an extensive series of animals being utilized, for a hill animal requires 18 times the dose that of a plains animal, whose body weight is 600 lbs. It would appear from the results obtained that the serum deposited in a pit at Nagpur, at a depth of 10 feet, in which the temperature is said never to have exceeded 90° F. deteriorated but slightly in value during its detention.

16. *Virulent spleen pulp.*—Experiments were continued with a view to producing a material in small bulk by which rinderpest could be reproduced in virulent form in the field, should animals require to be protected by the simultaneous method in a part of the country where the disease was non-existent. For this purpose, the spleens of animals affected with rinderpest were removed at the time of death and passed through the mincing machine until the whole tissues of the organ were pulped. This material was then removed and dried in the exsiccator over sulphuric acid in vacuô, for periods of from 3 to 10 days; the following are the results of the experiments conducted with the same material:—

(*a*) *Material dried in vacuô for three days.*—This was tested on a hill bull on the day it was removed from the exsiccator and powdered. It was then found to have retained its ordinary virulence, killing hill cattle in six days.

(*b*) *Material dried in vacuô for eight days.*—This powder was tested on hill bulls first when removed from the exsiccator and again after a period of 59 days.

The animal inoculated with the material on removal died of typical rinderpest, and in the latter experiment the hill bull showed a rise in temperature to 40·6°C. on the third evening, vesicles, etc., appeared on the fifth and death followed on the 11th day of disease. During the interval above referred to, the powdered spleen was placed in a stoppered bottle well secured from the air and was kept in the dark.

17. *Rinderpest in black buck.*—A black buck exposed to the "*contagium*" of rinderpest contracted the disease spontaneously and succumbed in due course. The autopsy showed that the so-called Peyers Patches were raised and velvety and that an intense congestion of the mucous membrane of the body was generally present.

This opportunity was embraced in order to test the virulence of the "*contagium*" of rinderpest in hill cattle, when previously passed through the black buck. For this purpose, a certain amount of the marrow of a long bone was removed as quickly as possible after the death of the animal. An emulsion was made with the marrow in physiological salt solution, and 1·0 c. c. injected subcutaneously into a healthy hill bull. The period of incubation occupied three and a half days, the temperature rose to 40·7° C. at the seventh observation, vesicles followed on the fifth day of disease instead of the third as is usually the case in hill bovines. Ulcers appeared 24 hours later together with diarrhœa; at the same time anorexia was present and persisted for a period of four days. The animal, however, recovered and was still alive three months later.

We may deduce from the above observations that this species of deer is liable to be affected by rinderpest and that susceptible animals are capable of contracting the disease from it by inoculation, but it would appear that the

causal agent of rinderpest loses its high degree of virulence for hill bulls, the most susceptible breed of cattle in India, by passage through the black buck.

18. *Piroplasmosis, Trypanosomiasis, Foot and Mouth, Stomatitis and Spirillosis in the blood of bovines.*—A considerable amount of research work has been accomplished with regard to Piroplasmosis, and Trypanosomiasis in so-called healthy cattle, occurring as secondary diseases to rinderpest.

19. *Piroplasmosis.*—After careful observation it has been proved that the great majority of hill bulls utilized at this Laboratory and also 50 per cent. or more of all plains bulls brought to Muktesar are the subjects of Piroplasma in one form or another. As it would occupy a large space in this report, it is my intention in the near future to publish a separate pamphlet on this most interesting form of disease as met with in this portion of India.

20. *Trypanosomiasis.*—Many new facts have come to light with regard to this disease in cattle, caused by the presence of a form of protozoon belonging to a genus of blood parasites in man and the lower animals, which, in the various forms discovered, are more or less at the present time occupying the attention of the scientific world. As in the case of the previous disease, much space would here be utilized in drawing attention to all the results of observation drawn from the protracted study of these organisms, a separate report will, therefore, be submitted and published at the first opportunity detailing in full the several points of interest encountered and dealt with.

21. *Foot and Mouth.*—This disease has been a source of great inconvenience during the year under report and full mention of the facts has been entered into under section III.

22. *Stomatitis.*—This disease occurred as a complication in hill animals during the early portion of 1906, the animals were segregated and but little delay was caused, as a consequence, in the work of the Laboratory.

23. *Spirillum in the blood of bovines.*—In the peripheral blood of hill bovines brought to Bareilly during the autumn of 1905, well developed spirilla were discovered, resembling somewhat the organism of relapsing fever in man. The mean length of each organism pointed at either extremity was 19 μ and was composed of nine spirals; each organism, however, showed a small area in its middle unstained, evidently the seat of division at a later stage of development.

The results of the observation were :—

(i) It was impossible to convey the spirillum by subcutaneous inoculation of blood to either monkeys or other small animals.

(ii) That this spirillum, although probably conveyed by a species of ticks, could not be detected in ticks removed from the host.

(iii) That emulsions of ticks removed from the sick bull did not reproduce the disease on subcutaneous injections in healthy animals.

24. A new form of sporozoon has been observed by me in the red blood corpuscles of some bovines. This will be described at a later date when time permits me to work out the various forms it assumes.

Anthrax.

25. Previous to the year under review, the method employed for the hyper-immunization of cattle against Anthrax was by subcutaneous injections of increasing doses of bouillon cultures. During the past 12 months, considerable saving of time, labour, a great reduction in the quantity of cultures utilized and a minimum risk to those conducting the operations, has been introduced by the use of the intravenous method of injecting the bovines as employed by us, for several years past, in the preparation of Hæmorrhagic Septicæmia serum.

Owing to the enormous increase of work in every direction and in addition, having our attentions directed to greatly enhanced supply of Hæmorrhagic Septicæmia serum and to the elaboration of prophylactics for Charbon Symptomatique, but little time could be found for investigating other questions of interest concerning Anthrax.

Hæmorrhagic Septicæmia.

26. This is an acute disease affecting for the most part buffaloes and cattle in this country, although it is pathogenic to some equines, deer and to a

less extent to sheep, goats and many small animals. Country-bred horses are immune but donkeys succumbed to inoculations of virulent blood. In some districts in this country, the disease is said to appear sporadically during the whole year, especially those localities which are marshy or intersected by rivers. The disease, however, becomes epizootic, as a rule, during the monsoon and during or after the Christmas rains. Several types of this disease may be encountered in the field, *viz.*, (i) Superficial or Cutaneous; (ii) Thoracic; (iii) Intestinal; and these in *acute* or *chronic* form. During the course of these researches, it has been found that hill animals are the most susceptible to Hæmorrhagic Septicæmia. Buffaloes and plains bovines coming next, in the order mentioned. It must, however, be distinctly recognized that the "materies morbi" differs in virulence considerably in different outbreaks, and further the susceptibility of the animals of various breeds exposed to the "contagium" likewise varies. Consequently, the periods which intervene, *viz.*, the incubation period of the malady and that between the exhibition of the first symptom recognisable and death, may also be found to vary considerably.

Experimentally it has been demonstrated that one large drop of a virulent broth culture of the organism of Hæmorrhagic Septicæmia inoculated subcutaneously, was sufficient to bring about death respectively in buffaloes, hill and plains bovines, in the following periods :—

(1) hill bovines in 23½ hours,
(2) buffaloes in 28 hours, and
(3) plains bovines in 28 to 42½ hours.

It will, therefore, be observed that there may be no time to treat acute cases, which frequently exhibit no symptoms of the disease, or only for a short period, *i.e.*, several hours before death.

It is laid down that one attack of this disease gives protection against a second one during the lifetime of the animal. We have found that animals which have passed through one attack of the disease and recovered possess an active immunity after an interval of two years, and this protection may be found in future experiments to extend for a much longer period.

27. *Preparation of Hæmorrhagic Septicæmia serum.*—The organism of this disease, as obtained in cultures from the blood of animals which succumbed in the field, has been found to vary in virulence to an enormous extent. Consequently, instead of utilizing several strains of the "causal agent" for the purpose of immunizing the necessary animals for the preparation of a polyvalent anti-bacterial serum, the same has been prepared at this Laboratory from cultures of the organisms after passing them through a series of highly susceptible animals until a minimal lethal dose had been arrived at. This procedure was adopted with a view to insure the serum being possessed of qualities capable, if possible, of granting in small doses a passive immunity against the most virulent strain to be encountered in the field.

28. *Summary of some results obtained with serum of bovines hyper-immunized with the Causal Agent of Hæmorrhagic Septicæmia.*—(i) The disease does not appear to infect by the gastro-intestinal tract unless there is an abrasion, for, animals drenched with large doses of virulent culture showed no symptoms during a further period of two weeks. The majority of such animals when tested with virulent culture at a later date succumbed.

(ii) Hill, in contra-distinction to plains, bovines require a larger dose of the anti-bacterial serum to produce protection.

(iii) Plains animals respectively injected subcutaneously with a standard dose of serum still possessed a full passive protection against the inoculated disease after a period of *four weeks*, but those tested after *seven weeks* succumbed.

(iv) The same standard dose, *viz.*, 5 c. c. of serum failed to protect hill cattle even for eight days. Such breed of cattle require a double dose (10 c. c.).

(v) Hill animals subcutaneously inoculated, by the simultaneous method (with 5 c. c. serum + 0·1 c. c. virulent culture) succumbed to the disease like ordinary unprotected animals.

(vi) Hill animals submitted to the simultaneous method (5 c. c. serum injected intravenously, and virulent culture 35 minutes later subcutaneously) were found to be protected.

(vii) Plains and hill buffaloes injected subcutaneously with 3 c. c. of serum and 48 hours later tested with virulent culture, were found at a later date to possess an active immunity.

(viii) A dose of 35 c. c. of serum injected intravenously in hill cattle has been found necessary to overcome the effects of a lethal dose of virulent culture injected subcutaneously 15 hours previously; the animals thus treated presented no symptoms of the disease. Consequently, this mode of treatment, on account of the large quantity of serum necessary, cannot be recommended except in the case of valuable cattle being attacked, and even then if any symptoms are exhibited, probably a much larger dose would be required than the one above mentioned.

29. *When bovines were hyper-immunized with the toxins produced by the causal factor of Hæmorrhagic Septicæmia.*—A plains bull, aged four and a half years, body weight 421 lbs., susceptible to this disease, was hyperimmunized with toxin prepared from the organism Hæmorrhagic Septicæmia allowed to remain in an incubator at 37° C. from 11th October 1904 to 15th May 1905. The doses of toxin injected subcutaneously varied from 1 c. c. to 110 c. c. during a period of four months, in all a total of 626 c. c. were injected. The body weight of the animal increased during this interval from 421 to 490 lbs.

On 18th July 1905, the animal was bled for the first time and serum prepared in order to test its immunizing power after the 8th injection, nine days after a dose of 80 c. c. had been injected. A dose of 5 c. c. serum and 48 hours later 0·1 c. c. virulent culture, failed to protect the animal, but 10 c. c., under similar conditions, only allowed of a slight thermal reaction, and a dose of 7·5 c. c. proved sufficient to protect. The animal was bled 2,200 c. c. on the 30th August and 3,000 c. c. on the 8th September, and later on the latter date was inoculated with 0·1 c. c. of a culture of Hæmorrhagic Septicæmia, to test the degree of susceptibility. A slight thermal reaction followed and concurrently a small swelling occurred at the seat of inoculation $2 \times 1 \times \frac{1}{4}$, which was quickly absorbed.

30. *Sera produced by hyper-immunizing bovines with certain organic substances, other than the causal agent of Hæmorrhagic Septicæmia.*—In a previous communication I pointed out that serum prepared by hyper-immunizing plains cattle with phytoglobulin or some nearly allied substance obtained from pumpkin seeds grown in the vicinity of Muktesar, on subcutaneous or intravenous injection into susceptible animals, was capable of conferring a resistance to the organism of Hæmorrhagic Septicæmia, which resistance could be changed into an active protection, should the animal be inoculated with a small quantity of culture of the "causal agent." Further, that this active resistance was found to be maintained two years after the primary protection had been conferred.

During the years 1902-1903, sera were also prepared by hyper-immunizing cattle with certain substances other than the causal agent of Hæmorrhagic Septicæmia, obtained from the testes of plains and hill cattle, and of buffaloes, and also from the seeds of plants. Additional sera were made from other organic substances such as *milk, yolk of egg, fish sperm and spawn, cell-protoplasm, mucin* and *yeast.* During the year under review, certain of the above sera, to which 0·5 per cent. carbolic acid was added in the first instance, have been retested as to their protective effects on the "contagium" of Hæmorrhagic Septicæmia, after they have been allowed to stand in the cold room at Muktesar for periods of from $2\frac{1}{2}$ to $3\frac{1}{2}$ years.

The following interesting and important results were obtained :—

The minimal lethal dose of Hæmorrhagic Septicæmia was found to be 0·1 c. c. of bouillon culture 48 hours at 37° C. This killed an animal of 240 lbs. body weight in 31 hours. Hill animals were respectively subcutaneously injected with the following sera prepared from *buffalo testes, yolks of eggs, casinogen, Para-nucleo-proteid* and *pumpkin seeds.* Each animal received 1 c. c. per lb. body weight of one of the respective sera, and 48 hours later was subcutaneously inoculated with 0·1 c. c. of virulent Hæmorrhagic Septicæmia culture. Some of the animals showed thermal reactions and recovered, with one exception, namely, the one subjected to para-nucleo-proteid serum. This animal succumbed in 35 hours 10 minutes, a little later than

the control. Others showed no thermal reactions, a sign that the dose of serum injected was too large and therefore the " causal agent " was destroyed, without conferring any active immunity. In order to prove this supposition, the surviving animals were again, after a period of eight days, subjected to a larger dose of Hæmorrhagic Septicæmia virulent culture, to test their degree of protection. It was found that the animals which had respectively exhibited thermal reactions, *viz.*, those which received doses of *buffalo testes serum, yolk of egg products* and *casinogen* survived the ordeal, and the others succumbed in various periods, demonstrating the fact that the passive immunity conferred was but of short duration.

In a second series of experiments with enhanced doses of Hæmorrhagic Septicæmia culture in the first instance, it was discovered that the serum prepared from the casinogen (milk) was the only one which stood the severe test, and in this case the animal exhibited no symptoms other than a slight thermal reaction, emphasizing the great power of this form of serum which 2 years and 9 months in bottles at the time of retesting still maintained its efficacy.

Equine Surra.

31. *To attenuate by passing through the body of animals.*—This question has been dealt with in a paper already published by me in the *Journal of Tropical Veterinary Science*, Part I, and the results of further experiments under investigation will be recorded in due course when they are concluded.

32. *By the administration of certain chemicals.*—The series of experiments commenced during last year which had for their object the cure of Equine Surra by the administration of arsenic and trypan-rot were continued during the last 12 months.

Of five country-bred ponies, the subjects of Equine Surra, two recovered after treatment with arsenic and trypan-rot. One of these animals had presented numerous to swarming trypanosomata in the blood for 19 consecutive days, previous to the commencement of the intravenous injection of the chemicals in combination, and a successful termination to the case was not anticipated. Death followed in the unsuccessful cases in 130, 134 and 191 days respectively after the commencement of the treatment.

Aged Australian horses, the subjects of Equine Surra, treated by the above methods, with doses according to their body weight, succumbed in 36 and 38 days; the flagellates being absent from the peripheral blood for periods of but 20 and 30 days respectively. It has been observed that the best time to inject arsenic and trypan-rot intravenously is not when the trypanosoma is present in large numbers in the peripheral blood of the animal, for then the toxin present in varying quantities appears to combine with the chemicals introduced and together they produce rapidly fatal results. It has been demonstrated by practical experience that the best effects are produced when arsenic in combination with trypan-rot are introduced intravenously on the first day of a paroxysm of Surra, when the *toxin* has been in whole or in part eliminated from the system of the animal, and this has allowed of the flagellate reappearing in small numbers in the blood of the peripheral circulation.

33. *To attenuate the trypanosoma by means of cultures.*—These experiments have been largely augmented during the past year, full advantage having been taken of all the new and improved media worked out by other observers in various parts of the world, but especially those put forward by Messrs. Novy and MacNeal, the originators of this line of research. Our experiments have not been as successful as could be desired, but when we compare the results which MacNeal has recorded together with his failures, we have no cause to lose heart at our results, for, the above-mentioned investigators recorded "fifty independent series of cultures trials had to be made by them before they could duplicate the last positive results."

34. *Surra in deer.*—With a view to determine whether black buck are capable of conveying the *T. Evansi* in their blood for long periods as in the case of bovines and thus being able by the aid of flies to disseminate the disease to other susceptible animals, three black buck were respectively inoculated with varying amounts of blood taken from control Surra Equines;

the one which received 0·2 c. c. exhibited an incubation period of three and a half days and succumbed on the third day of the malady with over one hundred trypanosomata in each field of the microscope (Leitz. Oc. 4 Obj. VII), maximum temperature 39·9°C., only 0·9°C. above the normal of health. The second animal pricked once only with the finest needle of a Pravatz syringe (detached from the body of the instrument) containing a trace of a drop of Surra blood (hæmatozoa 17 in a field of the microscope) succumbed to an acute Septicæmia, the blood at the time of death containing an enormous number of Bipolar staining *Cocco-bacilli.* The third animal was also once pricked with a small needle detached from the Pravatz syringe in the skin of the back. In this instance, the contained Surra blood presented seven trypanosomata in a field of the microscope. The incubation period occupied four and a half days. Two paroxysms occurred lasting 12 and 15 days respectively and two intermissions of 3 and 10 days, death taking place on the first day of the third paroxysm with one flagellate in 25 fields of the microscope. Course of disease 41 days.

From the above experiments one may draw certain deductions—(i) That all black bucks do not exhibit the same degree of susceptibility to *T. Evansi.* (ii) That toxin is not readily elaborated, for the trypanosomata swarmed between 60 and 100 in each field for six consecutive days in No. III buck, without making any appreciable difference on the number of flagellates in the peripheral circulation. (iii) That the black-buck is not capable of carrying over the trypanosoma from the end of one Surra season to another. (iv) That this species of deer is very susceptible to *wildseuche.*

Camel Trypanosomiasis.

35. *Attenuation of the trypanosoma by passing through the body of animals, before testing on Equines.*—An article appeared in the *Journal of Tropical Veterinary Science* dealing largely with this question embodying some of the most important results, hitherto arrived at. This subject will be further dealt with in the Report on Camel Trypanosomiasis mentioned later in this communication. It was noted in my last year's report that two country-bred ponies each received 20 c. c. of blood, containing 20 flagellates in a field, subcutaneously, on the 24th November 1904, from a camel, the subject of spontaneous Trypanosomiasis, with a view to being further tested when the "causal factor" of the disease finally disappeared from the blood of the peripheral circulation in each case respectively. One animal, however, succumbed to complications, partial consolidation of both lungs and hydatid cysts, etc. The second, however, after a period of incubation, lasting four and a half days, has exhibited 44 paroxysms and is now on the 28th day of the 44th intermission, or the 570th day since the appearance of the flagellate in the blood. Consequently, the final tests with the injection of camel blood and later, if satisfactory, with Equine Surra blood, cannot yet be carried out.

36. *By the administration of certain chemicals.*—Although, as early as 1893, I recommended arsenic in the form of Liquor Arsenicalis to be administered to camels, the subjects of Trypanosomiasis, mixed with their food, and this system of treatment proved to be of value in some cases, no knowledge of any kind was forthcoming with regard to the tolerance of camels to the subcutaneous or intravenous injection of arsenical solution alone or in combination with trypan-rot. Therefore, our first care was to make experimental researches for the elucidation of these problems.

The doses of arsenic and trypan-rot well tolerated by equines in this country, when injected intravenously, in combination, have been proved to be lethal to camels in the course of a few hours. Camels appear to be very susceptible to the action of arsenic and trypan-rot in combination, as colic followed small doses intravenously. Two-thirds of the doses administered to equines was tolerated by camels, and produced no severe symptoms; nevertheless, such doses only kept the flagellates in check for varying short periods, when they again appeared in the peripheral blood in increased numbers and death followed.

A fairly comprehensive report on Camel Trypanosomiasis, the collected results of experiments which have now been in course of investigation during

a period of four years, with special reference to the life history of the causal agent, has been almost finished and will be published at the first opportunity.

37. A new form of organism has been discovered by me in the erythrocytes of some camels suffering from spontaneous trypanomiasis. Specimens have been forwarded to Professor Schaudinn for favour of identification. The organism presents the appearance of a long thread, one extremity terminating in a small protuberance. Individually the length varies from 25μ to 26·25μ. The organism may be observed at one stage of development following the exact contour of a red blood cell, while in another, it forms a figure of 8 in the interior of such a cell, or projects half its length from it. Less seldom the organism may be discovered lying free in the blood plasma.

Charbon Symptomatique.

38. Very extensive researches have occupied a portion of our time during the past 12 months in attempting to procure a serum to protect against Charbon Symptomatique in bovines. Our greatest difficulty has been connected with the production of virulent cultures for the purpose of hyper-immunizing animals. All known methods have been tried but without success. Consequently, we have been obliged to fall back upon the use of the muscle juice of animals, which have succumbed to the disease, for the periodical injection of the serum giving animals. In due course, the serum will be ready for the test experiments as to the dose it is to be issued at.

In the field, this process of serum injection will only confer a passive protection for a short interval on the injected animal, whereas the first and second vaccines prepared from muscle juice of animals, which have succumed to Charbon Symptomatique, will produce an active immunity upon the injected animal after the reaction following the injection of the second vaccine. Consequently, a large number of doses of various vaccines are in the course of preparation by the following different methods and will shortly be ready for testing in the field, during the coming wet season. The simplest and most efficient method may then be introduced and its preparation continued :—

(i) First and second vaccines from muscle juice obtained from animals which have succumbed to Charbon Symptomatique.

(ii) A third form of vaccine from the defibrinated blood of bovines which have succumbed to the malady.

(iii) A fourth form of vaccine from the defibrinated blood of bovines suffering from Charbon Symptomatique, but utilizing the heart blood collected half an hour after death.

(iv) A fifth method is to use the spleen of Charbon Symptomatique carcasses by squeezing out the juice, letting it dry, then mincing and exsiccating the same over sulphuric acid.

Dourine.

39. Further observations in considerable numbers have been continued during the past 12 months. Material has now been collected since the publication of the first report in 1904, which will allow of my submitting, in due course, a further communication on the subject. This will contain a considerable amount of information with regard to the intimate changes observed in the nervous system produced by the toxins elaborated in the course of Dourine. Some time must, however, elapse before my notes can be put in proper form for publication. This cannot be undertaken until towards the end of the present year, after the enhanced work, consequent upon lectures and training of Veterinary Officers, has terminated.

40. *Treatment of Dourine by Arsenic and Trypan-rot.*—This has only been carried out in one animal, an Arab T.B. horse, the subject of 71 plaques, previous to the commencement of the treatment, and also of marked œdema and swelling of scrotum, sheath and under-surface of the abdomen. Arsenic and trypan-rot were administered intravenously in doses previously worked out, as those tolerated by equines the subjects of Equine Trypanosomiasis. The results, as observed up to the present, have been satisfactory ; the swelling and œdema disappeared and the effects of covering were negative.

Tuberculosis in Camels.

41. In my letter No. 108 C., dated the 16th January 1906, I reported to the Inspector General, Civil Veterinary Department, the fact that a camel received at Bareilly on November 22nd, 1905, in very poor condition, supposed to be the subject of Camel Trypanosomiasis and previously under observation for a period of 51 days, had suddenly succumbed. At the autopsy, conducted immediately after death, extensive pathological changes were observed in the lungs and the post-tracheal glands, due to the presence of what appeared to be tuberculosis. This subject is still under investigation, as it is one of considerable interest, the casual agent, in the first instance, differing considerably from the bacilli found in human, bovine and avian tuberculosis. Guinea pigs inoculated with material from the lung of the affected animal succumbed to general tuberculosis after periods of 114 and 96 days, respectively. This series is being continued to obtain further results.

Glanders.

42. During the latter part of 1905 and the early portion of the present year, a certain number of cases in equines were observed the symptoms of which simulated true glanders, but which failed to react to approved Mallein. Guinea pigs inoculated by the Strauss method, either failed to give any marked reaction, or when such was present, the results passed off without producing serious symptoms, until a much later date. Death, however, eventually occurred in about 43 days, instead of in from 8 to 15, as in the case of virulent glanders. The organism, obtained from material received from the Bombay Vete rinary College, when cultures were made at Bareilly and later at Muktesar, resembled somewhat the *B. Mallei*, but was shorter and not so wide. After passage through a number of equines the Bombay Bacillus became much more virulent, and the cultures which at first failed to produce a brown colour on potato, finally did so, the colour produced being of the same hue or even slightly darker than the growth of the *B. Mallei*. Further, Mallein in 1·0 c. c. doses prepared from the Bombay organism, and injected into a pony, the subject of true glanders, produced a thermal and a local reaction at the seat of injection.

From the above observations, it would appear that in this country the virulence of the *B. Mallei* may become reduced, owing to some cause or causes not yet determined, and that under some conditions, an animal suffering from a mitigated form of disease may fail to exhibit a reaction when injected with approved Mallein. This investigation is being continued and will be the subject of a full report when the important results observed have been thoroughly studied.

Tuberculine.

43. On the 11th September 1902, tuberculine was prepared in ordinary glycerine, beef bouillon from a cultivation of *B. Tuberculosis Bovis* received from Berlin. The flask containing the bouillon culture was kept in an incubator at 37°C. for a period of over six weeks. The contents of the flask were sterilized three times at 100°C. for 20 minutes on each occasion, then filtered through paper and evaporated over a boiling " bain-marie " to one-tenth of its original bulk. The residue was then placed in a tightly fitting brown glass stoppered bottle without added carbolic acid and was kept in the dark, at room temperature for a period of four years. On the 4th August 1905, the contents of the bottle were examined, then it was observed that numerous round white balls were present measuring up to two millimetres in diameter. On microscopical examination, these balls were found to consist of bacilli massed together, and when stained with Zhiel and later decolourised with 30 per cent. nitric acid and counter-stained with Methyl. Blue, the whole of the bacilli were found to have retained the red colour, and corresponded exactly with the B. Tuberculosis.

Guinea pigs, inoculated on the 4th August 1905, were found to be perfectly healthy when destroyed on the 21st January 1906, and a third guinea pig, inoculated intraperitoneally with 1·0 c. c. of fluid, containing a considerable number of disintegrated balls at bacilli in bouillon, at a subsequent date

showed no rise in temperature or other symptoms of tuberculosis. This observation tends to emphasize the importance of passing tuberculine through a porcelain filter during the process of preparation, for, although the bacilli proved to be inert after a period of four years, they must have retained their vitality in the first instance in order to increase in number, but even then it is questionable whether they could have retained their virulence.

44. *Specimens examined.*—During the year under report, 101 specimens containing in some instances several different objects for examination, were received at the Laboratory. The majority of these specimens were submitted with a view to determine the presence or absence of the cryptococcus of Lymphangitis Epizootica and the causal factors of various forms of Trypanosomiasis. In other instances, tissues were forwarded for diagnosis and report. In each case the result of examination was reported to the respective person interested after the shortest possible interval.

Section III.

Application of the result of research.

45. Foot and Mouth disease has caused much inconvenience during the past twelve months. First it appeared in July and August and, at a later date, during the months of December 1905 to March 1906; it stopped the preparation of rinderpest serum to a great extent.

46. During the autumn of 1905, extensive arrangements were entered into for the preparation of rinderpest serum by hyper-immunizing a large number of extra plains bulls, so that they would be available for serum giving should it be impossible to bring hill bulls to the Laboratory estate, in the event of Foot and Mouth or any other disease interfering with the further preparation of this serum. To this foresight, with regard to precautionary measures, we have much to be thankful for, as during four months, December 1905 to March 1906, some nine batches of hill bulls arrived in Muktesar, some affected with Foot and Mouth disease but in the *majority* of instances in apparently good health. The period of segregation, lasting 10 to 14 days, is rigorously carried out with each batch of animals on their arrival at Muktesar. Unfortunately, many of the animals in the respective batches, supposed to be healthy on their arrival, after an interval of a few days (2 to 5), were observed to exhibit symptoms of Foot and Mouth disease and it took nearly six weeks or longer for the animals of each batch to completely recover and be fit for use.

In this connection, it must be noted, that the roads in the Kumaun Division between the Bhootia villages in the mountains are for the greater part of the year infected with Foot and Mouth disease due to Bhootia cattle traversing them and therefore the following strict instructions were issued to our agents in the Himalayas :—

(i) To collect no animals from those districts in which Foot and Mouth was known to exist.

(ii) To segregate all animals for at least three weeks before despatching to Muktesar.

(iii) To avoid public high roads by which Bhootias take their cattle and to send the animals for the Laboratory by round-about routes, little or seldom frequented by Bhootias.

47. It is of interest to note that by careful antiseptic and other precautions we were able to confine the above-mentioned disease to the outskirts of the Laboratory estate, and, for this reason, the animals previously hyper-immunized during the autumn, produced a certain amount of serum, but this could not be tested at Muktesar for want of hill bulls. The difficulty was, however, overcome, as work is carried on at Bareilly during the winter months, and we were, therefore, able to test and continue to issue the Muktesar serum, with a minimum of inconvenience to the indenting officers, as during the cold season we keep a certain number of hill cattle at the Bareilly Depôt for experimental purposes.

48. *Rinderpest Serum.*—The quantity of anti-rinderpest serum prepared during the year under report, was equivalent to 1,198,569 c. c. or about 211,407

doses and the total issue 1,296,764 c. c. or 204,979 doses as per detail shown in Appendix I.

The following statement will show at a glance the marked increment both in output and issue of the anti-rinderpest serum during the last four years:—

Year.	Quantity prepared.	Quantity issued.
	Doses.	Doses.
1902-1903	73,288	87,791
1903-1904	122,061	114,798
1904-1905	151,855	130,810
1905-1906	211,407	204,979

49. The returns received in this office, during the past year concerning the serum injections carried out in the field, by the serum alone method, have been collated under their respective provinces as follows:—

50. *Punjab*—

Injections with serum alone.

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak,			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Gurdaspur	April, November and December 1905 and January, February and March 1906.	9	...	50	...	...	1,474	...	...	...	...	
Amritsar	April and May 1905 and March 1906.	6	...	3	...	...	610	...	...	...	...	
Shahpur	April, August, November and December 1905 and February and March 1906.	26	...	536	...	...	12,123	...	...	2	...	
Gujranwala	April and July to December 1905 and March 1906.	18	...	122	...	...	3,796	...	...	...	...	
Jhelum	April, September, October and December 1905 and February and March 1906.	7	...	76	...	...	6,356	...	...	...	...	
Gurgaon	April 1905	2	...	...	...	...	210	...	...	...	...	
Karnal	May and September to December 1905 and January and February 1906.	21	...	406	...	...	5,836	...	...	5	...	
Lahore	May 1905	1	...	...	...	...	211	...	...	1	...	
Lahore Veterinary College.	December 1905 and February 1906.	2	...	...	...	...	10	...	...	...	...	
Umballa	August and December 1905 and March 1906.	4	...	85	...	...	1,691	...	...	...	...	
Kangra	September 1905, January and February 1906.	3	...	22	...	...	822	...	...	...	...	Hill cattle.
Gujrat	September, October and December 1905.	4	...	36	...	...	1,067	126	...	...	...	
Jhang	September to December 1905 and January and February 1906.	21	...	472	...	...	3,037	583	...	...	...	
Hoshiarpur	December 1905 and January 1906.	6	...	70	...	...	1,283	...	...	...	...	
Jullundar	January 1906	1	...	4	...	...	46	...	...	...	...	
Sialkot	January and March 1906.	2	...	28	...	...	443	...	...	1	...	
Rawalpindi	Ditto	3	...	14	...	...	2,101	...	...	...	...	
Government Cattle Farm, Hissar.	February and March 1906.	2	...	...	...	...	491	...	...	2	...	
Hissar	Ditto	2	...	24	...	...	518	...	...	1	...	
Rohtak	February 1906	2	...	29	...	...	500	...	...	...	...	
Lyallpur	Ditto	2	...	45	...	...	490	...	...	...	...	
Ferozepore	Ditto	24	...	270	...	...	6,163	...	...	...	...	
Ludhiana	March 1906	2	...	48	...	...	77	...	...	6	...	
	Total	170	...	2,340	...	...	50,050	709	...	18	...	Death-rate 0·035 per cent.

Out of 50,050 head of cattle and 709 ovines injected by the serum alone method in 170 outbreaks, occurring in 21 districts of the Punjab, only 18 animals or 0·035 per cent. died of rinderpest after inoculation, whilst in the same outbreaks 2,340 animals had succumbed before the serum injections were undertaken.

In the Kangra District 822 head of *hill cattle* were injected in three outbreaks and no death occurred after the serum was injected.

These extraordinary results, especially the latter, emphasize the great efficacy of the serum utilized.

51. *North-West Frontier Province.*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Kohat	June, July and August 1905 and January 1906.	11	...	447	7	...	3,566	30	...	...	...	
Peshawar	September and December 1905 and January to March 1906.	25	...	465	...	...	9,200	...	...	12	...	
Kurram	November and December 1905.	18	...	147	...	...	2,380	...	...	...	...	
	Total	54	...	1,059	7	...	15,146	30	...	12	...	Death-rate 0·07 per cent.

In three districts of the North-West Frontier Province, of 15,146 bovines and 30 ovines injected with "serum alone" 12 or 0·07 per cent. succumbed to rinderpest.

52. *United Provinces of Agra and Oudh.*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Dehra Dun	April 1905	2	...	...	...	...	60	...	...	...	...	
Bijnor	April, August, November and December 1905 and January 1906.	19	...	112	...	...	1,648	...	...	4	...	
Bahraich	July and September 1905 and February 1906.	4	...	...	...	...	122	...	...	...	...	
Kheri	August and September 1905.	5	...	16	...	...	58	...	...	...	...	
Meerut	September and October 1905.	2	...	43	...	...	854	...	...	...	...	
Gorakhpur	September to December 1905 and January and March 1906.	20	...	119	...	...	618	...	...	...	...	
Saharanpur	December 1905 and January 1906.	2	...	52	...	...	1,032	...	...	...	...	
Garhwal	Ditto	2	...	99	25	...	305	103	...	42	8	Hill animals.
Muzaffarnagar	March 1906	1	...	49	...	...	813	...	...	...	...	
Mirzapur	Ditto	3	...	...	...	...	201	...	...	...	...	
	Total	60	...	490	25	...	5,711	103	...	46	8	Death-rate 0·92 per cent.

Referring to the above table, it may be noticed that, out of 5,814 animals injected with "serum alone" method in 60 outbreaks of rinderpest, 54 succumbed to rinderpest after inoculation with a mortality of 0·92 per cent.

53. *Bengal.*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10.	11	12	13
Palamau .	April and May 1905 and January 1906.	8	...	10	...	...	284	...	...	10	...	
Cooch Behar .	January to September 1905 and February and March 1906.	15	...	...	...	...	582	...	...	14	...	
Cooch Behar State.	April 1905 . .	2	...	...	...	...	77	...	...	2	...	
Calcutta .	April, July and October 1905 and January to March 1906.	9	...	...	...	...	1,691	...	...	1	...	
Jalpaiguri .	May, July, August, November and December 1905 and January to March 1906.	15	...	638	...	...	3,285	...	...	8	...	
Mymensingh .	May and July 1905 .	10	...	3	...	...	242	...	...	32*	...	* 31 inoculated in a very advanced state of disease.
Khurda (Puri) .	May 1905 . .	17	...	...	...	...	575	...	...	2	...	
Chittagong .	June, July and August 1905.	20	...	280	...	...	1,966	...	...	23	...	
Burdwan .	June 1905 . .	2	...	19	...	...	134	...	...	1	...	
Balasore .	July and December 1905 and January and March 1906.	23	...	273	...	...	1,430	...	...	2	...	
Murshidabad .	July 1905 . .	1	...	9	...	...	57	...	...	...	...	
Tippera .	Ditto . .	1	...	25	...	...	447	...	...	22	...	
Sylhet .	July to October 1905 .	12	...	466	...	...	2,771	...	...	9	...	
Khulna .	August 1905 . .	9	...	130	...	...	569	...	...	...	...	
Noakhali .	October 1905 and February and March 1906.	16	...	991	...	...	3,579	...	...	20	...	
Midnapur .	November 1905 .	1	...	12	...	...	85	...	...	9	...	
24-Parganas .	November 1905 and February and March 1906.	11	...	...	...	...	1,566	...	...	2	...	
Darjeeling .	December 1905 and January and February 1906.	5	...	279	...	...	358	...	...	2	...	
Cachar .	February and March 1906.	7	...	296	...	...	1,484	...	...	2	...	
Hazaribagh .	February 1906 . .	1	...	...	...	...	800	...	...	...	...	
Muzafferpore .	Ditto . .	1	...	59	...	...	109	...	...	...	...	
Santhal Parganas.	Ditto . .	6	...	43	...	...	518	...	...	5	...	
	Total .	192	...	3,533	...	...	22,609	...	...	166	...	Death-rate 0·73 per cent.

The above returns from 22 districts of Bengal show that of 22,609 head of cattle injected in 192 outbreaks of rinderpest, 166 or 0·73 per cent. died after inoculation.

Although not stated in the Bengal returns, we must note that a number of the districts mentioned above are evidently in the hills, consequently, the returns show excellent results when it is remembered that this breed of cattle (hill) are so highly susceptible to the disease.

54. *Central Provinces and Berar.*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Bhandara .	April to July and September 1905.	19	...	311	...	..	512	...	...	3	...	
Seoni . .	April, June, July, September and October 1905.	7	...	170	...	...	530	...	...	2	...	
Wardha . .	April 1905 . .	1	...	...	...	...	25	...	...	...	...	
Nagpore .	May, June and August 1905 and February 1906.	8	...	111	...	...	433	...	...	...	...	
Balaghat .	May, June and September to November 1905 and January 1906.	33	...	796	...	...	1,430	...	...	...	...	
Akola . .	May 1905 and March 1906.	5	...	...	...	...	412	...	...	...	...	
Amraoti .	May, June and September 1905 and January to March 1906.	11	...	252	...	...	1,390	...	...	3	...	
Ellichpore .	June 1905 . .	2	...	49	...	...	217	...	...	...	...	
Raipur . .	July and November 1905 and March 1906	5	...	94	...	...	332	...	...	...	...	
Betul . .	July 1905 and March 1906.	5	...	49	...	...	298	...	...	...	...	
Chindwara .	October 1905 . .	2	...	128	...	...	101	...	...	...	...	
Yeotmal .	October and November 1905 and January 1906.	3	...	78	...	...	657	...	...	...	...	
Hoshangabad .	November 1905 January and February 1906.	18	...	121	...	...	326	...	...	...	...	
Jabbalpur .	November 1905 and January 1906.	8	...	264	...	...	420	...	...	...	...	
Nimar . .	March 1906 . .	1	...	40	...	...	104	...	...	...	...	
	Total .	128	...	2,463	...	...	7,187	...	...	8	...	Death-rate 0·11 per cent.

From the above table it may be observed that in 128 outbreaks, out of 7,187 cattle injected with anti-rinderpest serum, only 8 or 0·11 per cent. succumbed to the disease after inoculation, although the mortality was high before the serum injection commenced. It would appear from the above figures of uninoculated animals which succumbed in the various outbreaks, that the time between the commencement of the disease and the treatment with serum was somewhat prolonged, otherwise such an excessive death-rate would not be recorded. This, however, may be accounted for by the time which intervened between the commencement of the outburst and the receipt of the information of the respective outbreaks in the head-quarters of the Province.

55. *Madras.*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Ganjam	April to December 1905 and January to March 1906.	39	...	436	...	...	5,066	...	...	39	...	
Godaveri	April to June and September to December 1905.	61	...	154	...	...	2,686	...	...	...	...	
Tanjore	June and August to October 1905.	18	...	6	...	...	2,341	...	...	3	...	
Bellary	June, July and November 1905.	9	...	48	...	...	246	...	...	...	...	
Kristna	January and February 1906.	26	...	115	...	...	1,469	...	...	...	...	
Tinnevelly	September and December 1905.	1	...	...	1	...	246	...	...	2	...	
	TOTAL	154	...	759	1	...	12,054	...	...	44	...	Death-rate 0·36 per cent.

The return shows that, out of 12,054 head of cattle inoculated with "serum alone" method in 154 outbreaks of rinderpest in the Madras Presidency, 44 or 0·36 per cent. succumbed to the disease after inoculation.

56. *Bombay.*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Betul, C. P.	March 1906	1	...	...	...	...	87	...	...	...	...	
Sholapur	Ditto.	1	...	...	...	...	18	...	...	...	...	
Thana	Ditto.	1	...	...	...	...	71	...	...	...	...	
	TOTAL	3	...	...	...	...	176	...	...	...	...	Death-rate *nil.*

The return shows that only 176 cattle were injected during the month of March 1906 in 3 outbreaks in the Bombay Presidency and no deaths were reported.

It is difficult to believe that in an extensive Province of India representing $\frac{1}{6}$th of the whole peninsula, rinderpest is not more frequently met with, when in the adjoining districts of Central Provinces and Berar the disease is so rife. This fact becomes all the more difficult to reconcile, when we state that cries for assistance reach us at Muktesar especially from Nassik and the districts in its close vicinity, from private individuals.

The deficiency in the subordinate Veterinary staff may account for the non-carrying out of serum injections.

57. *Assam*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Dibrugarh	May 1905	22	...	...	...	...	1,996	...	...	13	...	
Sibsagar	June, July and August 1905 and March 1906.	7	...	282	...	...	1,652	...	...	10	...	
Darrang	November 1905	1	...	200	...	...	150	...	...	...	...	
Lakhimpur	December 1905	1	...	300	...	...	107	...	...	...	...	
	Total	31	...	782	...	...	3,905	...	...	23	...	Death-rate 0·58 per cent.

In 31 outbreaks of rinderpest from the four districts of Assam, 3,905 cattle were injected with "serum alone" of which 23 died with a mortality of 0·58 per cent.

From the above returns, it is difficult to determine the cause of the large mortality previous to injection with serum, as we are not in possession of facts with regard to the respective breed of bovines operated upon. One thing, however, is clear, namely, that the great majority of animals were highly susceptible to rinderpest and that the injection of serum was not carried out until sometime after outbreak commenced.

58. *Burma*—

Injections with "Serum alone."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Myingyan	April and May 1905	45	...	...	...	...	2,766	...	...	57	...	
Yamethin	June and July 1905	43	...	931	...	...	1,101	...	...	...	...	
Kyaukse	December 1905	17	...	80	...	...	1,077	...	...	...	...	
Toungoo	January 1906	1	...	3	...	...	15	...	...	...	...	Municipal cattle.
Pegu	February 1906	12	...	56	...	...	1,376	...	...	1	...	
	Total	118	...	1,070	...	...	6,335	...	...	58	...	Death-rate 0·91 per cent.

It is evident from the above return that, of 6,335 cattle injected with "serum alone" in 118 outbreaks, 58 or 0·91 per cent. succumbed to the disease, and that a large proportion of bovines were susceptible to rinderpest.

59. *Foreign countries.*—The Veterinary Surgeon, Singapore, in his letter dated 25th April 1906, to the address of the Imperial Bacteriologist states :—

"The serum has been of the greatest use in cutting short what promised to become a very serious outbreak, and I have applied to my Government to provide this Department with a stock of 400 doses to keep on hand in case of emergency."

60. The total number of outbreaks in India and Burma dealt with during the year under report was 910, in which 124,015 animals were injected by the "serum alone" method against 56,483 during 1904-1905. The mortality was 0·31 per cent. amongst the injected animals as compared with 0·46 per cent. during the last year.

In estimating the good work accomplished during the year with anti-rinderpest serum, the number of animals injected is not of so much importance as the number of different outbreaks of the disease *successfully* dealt with.

Before the serum treatment was introduced, some years ago, the disease was observed to spread across the country like a wave of the sea, leaving the

carcasses in enormous numbers in its wake. Now, instead of thousands of animals succumbing as the result, in some instances, of only one unchecked outbreak, it is becoming difficult in those provinces which are in the van of serum therapy to observe any large outbreaks at all. This result is easily understood when we consider that, in the above-mentioned provinces, immediately an outbreak is discovered by those in charge, the whole of the affected and contact animals are injected with serum or a cordon of protected cattle is formed round the primary focus of the disease and its further progress stopped.

61. *Anthrax.*—During the year 1905-1906, 224,310 c. c. of Anthrax protective serum which is equivalent to 44,862 doses, were prepared, as against 27,471 doses during the previous year. The total issue, as per Appendix II, was 26,712 doses. The demand for this serum was greater by 4,321 doses than that of the last year and by 18,647 doses than of the year before last.

62. The following abstracts from the returns of the Superintendents, Civil Veterinary Department, will show the results of injections carried out with Anthrax protective serum in their respective provinces:—

63. *United Provinces.*—

Injections with Anthrax protective serum.

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Hamirpur	April 1905	3	...	...	...	...	500	...	...	...	...	
Faizabad	June, August and September 1905.	40	...	58	...	...	579	...	...	...	...	
Muzaffarnagar	September 1905	1	...	9	...	...	385	...	...	...	...	
Gonda	October and December 1905.	2	...	5	...	...	406	...	...	...	...	
Bijnor	November 1905	10	...	15	...	...	418	...	...	...	...	
Azamgarh	Ditto	1	...	24	...	...	105	...	...	...	...	
	Total	57	...	111	...	...	2,393	...	...	...	...	Death-rate *nil.*

It will be noticed that, out of 2,393 head of cattle injected with Anthrax protective serum in 57 outbreaks of the disease in the United Provinces of Agra and Oudh, no death was reported after injection.

64. *Results of the use of anti-Anthrax serum in an outbreak of the disease in human beings.*—A severe outbreak of Anthrax occurred amongst the prisoners working in wool at the Central Jail in Bareilly in December 1905, and, on my suggestion, the Medical Superintendent undertook to utilize the anti-Anthrax serum, prepared at this Laboratory, to treat those persons already affected and to grant a passive immunity to those already exposed to the "contagium." Major E. Jennings, I.M.S., has kindly supplied me with the following details of the outbreak:—

Number of cases affected.	Number of deaths before serum treatment.	Number injected with anti-Anthrax serum.	Number recovered.	Number died after injection.	Remarks.
†Twelve with Anthracæmia, and one with malignant pustule.	3	9	5	4*	*Two cases were not treated with serum until tetanic spasms had supervened and two which were progressing most favourably, in spite of implicit orders to the contrary, feeling better sat up in bed and fell back dead. †In addition, 4 doubtful cases, 3 of which were treated with serum, all recovered.

Note.—In four cases which received serum, but ultimately died, compared with those which did not receive serum and succumbed, life was considerably prolonged.

Further, as an additional 60 men had been in contact with the contaminated wool, it was thought advisable to administer to each of them 5 c. c. of serum subcutaneously as a prophylactic. No untoward symptom occurred in 59 of the above cases. However, 14 days after the respective injections of serum had been made, one man contracted the disease but recovered. During the said period of 14 days all the men were in great peril of contracting the malady as they were employed cleansing the wool sheds where the infected material was stored.

There were seven deaths in all giving a death-rate of 58·33 per cent., the case of malignant pustule not being included in the calculation. The three cases in which serum was not utilized all succumbed, and out of nine, which were treated with serum, four deaths occurred giving a mortality of 44·4 per cent. If we eliminate the two cases in which the tetanic spasms were present, previous to the injection of serum, and also the two cases which were progressing favourably after the discontinuance of the serum treatment but succumbed on assuming the semi-upright position, then the mortality in the cases treated by anti-Anthrax serum was *nil*. Previous experience dictated that there would be but little chance of success with the serum in cases which exhibited advanced nervous complications, but it was deemed advisable to give the patients the benefit of the serum treatment.

All the cases treated benefited by the serum injections, and the only regret of the Medical Superintendent was that the serum treatment had not been utilized earlier, and in the two advanced cases of the disease, which exhibited marked nervous symptoms, intravenous injection had not been had recourse to instead of subcutaneous.

65. It is for those in authority to consider the advisability of depositing a certain quantity of Anthrax serum of high potency, in sealed tubes for immediate use in all Jails in which foreign or home wool or goat hair is utilized in the manufacture of Jail products. The preparation of such a serum would be an easy matter in this Laboratory, but it would take a period of five months to prepare one possessing a high protective value.

66. *Assam.*—

Injections with "Anthrax protective serum."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Sibsagar	April and December 1905.	4	...	10	...	...	866	...	...	2	...	
	Total	4	...	10	...	...	866	...	...	2	...	Death-rate 0·23 per cent.

In four outbreaks of the Sibsagar District in Assam, out of 866 cattle injected with Anthrax protective serum by the serum alone method, 2 animals or 0·23 per cent. have been reported to have succumbed to the disease.

67. *Madras.*—

Injections with "An'hrax protective serum."

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	1
Ganjam . .	April, June, August, November and December 1905 and January 1906.	19	...	123	...	...	1,951	...	...	5*	...	*It is reported that 2 died of Foot and Mouth.
Tanjore . .	April to December 1905, January and February 1906.	44	...	210	90	...	10,418	1,874	...	31	...	
Gantur . .	June to August 1905 and January 1906.	24	...	...	...	...	1,743	...	...	...	...	
Chingleput .	June and July 1905 .	4	...	...	...	...	327	...	...	...	...	
Bellary . .	June to September 1905 and January to March 1906.	22	...	79	...	...	1,223	...	...	14	...	
Godaveri .	July and August 1905, and January 1906.	6	...	14	...	...	482	...	...	...	...	
Nellore . .	September and December 1905.	63	...	95	...	...	3,176	...	...	13	...	
Tinnevelly .	January and February 1906.	5	...	1	115	...	19	1,438	...	...	3	
	TOTAL .	187	...	522	205	...	19,339	3,312	...	63	3	Death-rate 0·29 per cent.

From the above table it may be observed that in 187 outbreaks of Anthrax, in the eight districts of Madras Presidency, out of 22,651 animals including 3,312 of the ovine class, injected with Anthrax protective serum, 66 or 0·28 per cent. succumbed to Anthrax and 2 animals to Foot and Mouth disease.

68. During the past year 25,910 animals were inoculated with Anthrax protective serum in 248 outbreaks, against 19,287 in 187 (outbreaks) during 1904-1905. The mortality was 0·26 per cent. in the injected animals.

69. *Hæmorrhagic Septicæmia.*—During the past official year 75,350 c. c. or 15,470 doses of Hæmorrhagic Septicæmia serum were prepared. From the first moment its success was assured and the demand for it, on account of the satisfactory results met with in the field, was very great. As much as 18,603 doses, including 3,153 doses balance in hand from the previous year, were all issued, and some 10,500 doses indented for, were unable to be complied with. In this respect it may be stated here that, even at the present time, no permanent shed for Hæmorrhagic Septicæmia animals has been built, although sanction for three has been received and one will be finished in the course of a few months' time. All serum supplied during the year under review has been prepared from the blood of cattle housed in temporary chappars to protect them from the inclemency of the weather. Further, it must be remembered that, in order to furnish Hæmorrhagic Septicæmia serum of high protective power, 5 c. c. per 600 lbs. body weight, such as has been distributed during the past year, requires a period of five months to elapse before the animal can be hyper-immunized to the required degree.

Owing to the great demand for this serum, which would appear to be taking the place more or less of Anthrax serum, special arrangements have been carefully entered into to meet the increased requirements during the current financial year, and it is hoped that the output may be at least three times that of last year.

70. This serum was only issued for the first time on the 23rd June 1905 to the Superintendents of the Civil Veterinary Department, for experimental

purposes and the following abstracts, made from the returns received from the said officers will indicate the results in their respective provinces :—

71. *Punjab.*—

Injections with Hæmorrhagic Septicæmia serum.

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Jullundur	July, August and October 1905 and February 1906.	10	...	93	...	...	331	...	...	...	...	Before the inoculations zamindars were against, but on seeing the good results they approved.
Ludhiana	July and December 1905 and January 1906.	5	...	51	...	...	470	...	...	...	...	
Lahore	October 1905 and January to March 1906.	6	...	111	...	...	981	...	...	1	...	
Amritsar	October 1905, February and March 1906.	4	...	56	...	...	475	...	...	3*	...	* Ill at time of inoculation.
Ferozepore	November and December 1905 and March 1906.	4	...	28	...	...	659	...	...	...	...	
Gurdaspur	November 1905	1	...	20	...	...	200	...	...	...	...	
Gujranwala	December 1905 and January and March 1906.	7	...	49	...	...	823	...	...	...	...	
Gujrat	December 1905, and March 1906.	2	...	31	...	...	493	...	...	...	...	
Shahpur	Ditto	1	...	3	...	...	176	...	...	...	...	
Sialkot	January to March 1906.	7	...	108	...	...	490	...	...	...	...	
Hoshiarpur	February and March 1906.	6	...	63	...	...	634	...	...	...	...	
Lyallpur	March 1906	7	...	251	...	...	1,044	...	...	1	...	
Montgomery	Ditto	1	...	23	...	...	215	...	...	...	...	
Jhang	Ditto	2	...	33	...	...	372	...	...	2	...	
			North-West Frontier Province.									
Hazara	February and March 1906.	4	...	27	...	...	710	...	...	7	...	
Peshawar	March 1906	1	...	20	...	...	354	...	...	...	...	
	Total	68	...	967	...	...	8,427	...	...	14	...	Death-rate 0·16 per cent.

It will be noted from the above return that, out of 8,427 head of cattle injected with "serum alone" in 68 outbreaks, 14 or 0·16 per cent. succumbed to the disease. Mr. Oliver, the Second Superintendent from the Punjab, reports: "The most striking results appear to have taken place at Barnala (Jullundar District) where, four days after the inoculation, an outbreak occurred in which twelve animals were attacked. It is interesting to note that the ten which died were animals which had not been inoculated, the other two which were inoculated contracted the disease in a mild form and recovered."

Captain Walker, Superintendent, Civil Veterinary Department, Punjab, noted "I beg to say that as far as can be ascertained the results of the inoculations that have been performed in this Province may be said to have proved satisfactory. The history of the outbreaks of this disease, however, is 'sudden appearance and equally sudden disappearance.' A certain number of victims are claimed and the outbreak is over."

72. *United Provinces.*—

Injections with Hæmorrhagic Septicæmia serum.

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Bulandshahr .	July and August 1905	3	...	25	...	...	484	...	...	...	...	
Mozuffarnagar.	August and September 1905.	2	...	32	...	...	918	...	...	...	...	
Banda . .	August to October 1905.	26	...	49	...	...	252	...	...	...	...	
Jhansi . .	September 1905 .	2	...	65	...	...	485	...	...	...	...	
Fyzabad .	September and October 1905.	5	...	4	...	...	122	...	...	...	...	
Hamirpur .	October and November 1905.	5	...	63	...	...	1,515	...	...	...	...	
Ghazipur .	October 1905 . .	1	...	43	...	...	200	...	...	...	...	
Gonda . .	December 1905 . .	1	...	...	...	...	79	...	...	...	...	
	Total .	45	...	281	...	...	4,055	...	...	...	...	Death-rate *nil.*

From the above return it will be observed that, in 45 outbreaks of Hæmorrhagic Septicæmia in the United Provinces of Agra and Oudh, 4,055 head of cattle were injected with Hæmorrhagic Septicæmia serum, but no death followed the injection.

73. *Madras.*—

Injections with Hæmorrhagic Septicæmia serum.

District.	Date.	Number of outbreaks in which inoculation was undertaken.	Number of animals died uninoculated in course of outbreak.			Number of animals inoculated.			Number of inoculated animals which died of the disease.			Remarks.
			Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
1	2	3	4	5	6	7	8	9	10	11	12	13
Tanjore . .	July and October 1905	7	...	22	...	...	487	...	...	...	...	
Tinnevelly .	December 1905 . .	1	...	7	...	...	346	...	...	...	...	
Bellary . .	February 1906 . .	2	...	30	...	...	136	...	...	...	...	
	Total .	10	...	59	...	...	969	...	...	...	...	Death-rate *nil.*

In 10 outbreaks in the Madras Presidency 969 bovines were injected with Hæmorrhagic Septicæmia and no death has been reported after the injection.

74. During the year 1905-1906, a total of 13,451 head of cattle were injected with the Hæmorrhagic Septicæmia serum in 123 outbreaks, and the mortality was 0·104 per cent. amongst the animals so treated.

75. *Mallein.*—During the year under review, 3,407 doses of Mellein were prepared at Muktesar as against 1,514 doses prepared during the last year.

On reference to Appendix IV it will be observed that, including 22 doses of English Mallein, 2,606 doses were indented for during 1905-1906.

76. *Tuberculine.*—As early as 1902, bovine tuberculine was manufactured at this Laboratory. Out of the above amount the following 11 doses were issued during the year under report :—

	Doses.
The Senior Veterinary Officer, Rawalpindi	3
The Residency Surgeon, Bangalore	6
Experiments at the Laboratory	2
	11

In addition to the above, 20 doses of French Tuberculine were obtained and issued to the Principal, Punjab Veterinary College, Lahore.

77. *Financial aspect.*—As noted in the last year's Annual Report, the preparation of different sera alone pays much more than the annual expenditure of this Laboratory, without taking into consideration the cost of research and educational work performed.

During the year under review, the actual preparation of rinderpest sera, etc., amounted to approximately 275,146 doses; (Rinderpest, 211,407, Anthrax, 44,862, Hæmorrhagic Septicæmia, 15,470, and Mallein, 3,407 doses).

Should the cost of such serum be taken at ₹1 per dose, as sanctioned by the Government to be charged to foreign countries, *i.e.*, ($\frac{2}{3}$rd of the sale price in South Africa) then a clear saving of ₹1,71,658 would have accrued to the Government of India.

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX No. I.

Table showing the amount of anti-Rinderpest serum manufactured and despatched during the year 1905-1906.

Amount manufactured.		Amount issued.		Remarks.
Stock.	c. c.	Abstract of issue.	c. c.	
Balance in hand from 1904-1905.	359,598	Issued as per detail below	1,270,645	
Manufactured during 1905-1906.	1,198,569	Utilized in experiments at Muktesar and Bareilly.	*26,119	* Inclusive of 565 c. c. not reported.
		Tested serum in hand	120,549	
		Untested serum in hand	140,854	
Total .	1,558,167		1,558,167	
		Serum in Powder.		
Balance in hand from 1904-1905.	2,194	Issued	*Nil.*	
		Balance available	2,194	
Total .	2,194	Total .	2,194	

Issue.

Province.	Serial No.	Month and date of issue.	To whom consigned.	No. of cubic centimetres.	No of doses calculated for plain animals.	Laboratory No of serum.	Standard.
							c. c.
Punjab . .	1	5th April 1905 .	Veterinary Assistant, Nawab Khan, Bhera, Shahpur.	3,050	1,016	XXIV	3
	2	10th ditto	Veterinary Assistant, Fazal Haq, North-West Railway, Batala.	3,900	1,300	„	3
	3	10th ditto	The Superintendent, Civil Veterinary Department, Punjab, Lahore.	3,150	1,050	„	3
	4	29th May 1905 .	Ditto ditto .	10,000	1,000	XXV	10
	5	9th June 1905 .	Ditto ditto .	10,100	1,010	„	10
	6	16th ditto .	Ditto ditto .	10,150	1,015	„	10
	7	23rd ditto .	Ditto ditto .	10,120	1,012	„	10
	8	19th July 1905 .	Ditto ditto .	10,500	1,050	„	10
	9	19th August 1905 .	Ditto ditto .	5,110	1,022	XXVI	5
	10	29th ditto .	Ditto ditto .	5,000	1,000	„	5
	11	5th September 1905 .	Ditto ditto .	5,000	1,000	„	5
	12	12th ditto .	Ditto ditto .	5,060	1,012	„	5
	13	26th ditto .	Ditto ditto .	5,250	1,050	„	5
	14	12th October 1905 .	Ditto ditto .	25,200	5,040	„	5
	15	21st ditto .	Ditto ditto .	25,200	5,040	„	5
	16	15th November 1905 .	Ditto ditto .	25,200	5,040	„	5
	17	25th ditto .	Ditto ditto .	25,020	5,004	XXVII	5
	18	4th December 1905 .	Ditto ditto .	25,025	5,005	„	5
	19	18th ditto .	Veterinary Assistant, Sant Ram, Nurpur, Pathankote.	45,040	9,008	„	5
	20	21st ditto .	The Superintendent, Civil Veterinary Department, Punjab, Lahore.	25,135	5,027	„	5
	21	10th January 1906 .	Senior Veterinary Officer, Peshawar .	4,080	816	„	5

Issue—continued.

Province.	Serial No.	Month and date of issue.	To whom consigned.	No. of cubic centimetres.	No. of doses calculated for plains animals.	Laboratory No. of serum.	Standard.
							c. c.
Punjab—*contd*	22	19th January 1906	The Superintendent, Civil Veterinary Department, Punjab, Lahore.	70,000	10,00	XXVIII	7
	23	25th ditto	Ditto ditto	35,000	5,000	„	7
	24	31st ditto	The Superintendent, Government Cattle Farm, Hissar.	4,200	600	„	7
	25	5th February 1906	The Superintendent, Civil Veterinary Department, Punjab, Lahore	35,000	5,000	„	7
	26	16th ditto	Ditto ditto	25,000	5,000	XXIX	5
	27	1st March 1906	Ditto ditto	9,200	1,314	XXVIII	7
				10,650	2,130	XXIX	5
	28	14th ditto	Ditto ditto	15,810	1,976	XXX	8
			Total	491,150	84,537		
United Provinces	1	1st April 1905	The Veterinary Assistant, Bijnor	955	318	XXIV	3
	2	25th ditto	The Veterinary Assistant, Moradabad	1,010	202	„	5
	3	26th August 1905	Mohammad Shah, Veterinary Inspector, Balawali (Bijnor).	1,030	257	XXIII	4
	4	20th September 1905	Veterinary Inspector, Meerut City	3,000	600	XXVI	5
	5	23rd ditto	Veterinary Inspector, Gorakhpur	2,580	516	„	5
	6	13th November 1905	The Veterinary Assistant, Bijnor	2,010	402	„	5
	7	30th ditto	The Veterinary Assistant, Saharanpur	3,030	606	XXVII	5
	8	10th December 1905	The Veterinary Assistant, Bijnor	1,760	352	„	5
	9	20th ditto	The Veterinary Inspector, c/o Kham Superintendent, Kotdwar.	2,010	402	„	5
	10	31st ditto	The Veterinary Inspector, Srinagar, Garhwal.	36,055	7,211	„	5
	11	15th January 1906	The Veterinary Inspector, Roorkee	2,055	411	„	5
	12	31st ditto	The Veterinary Inspector, Bahraich	1,400	200	XXVIII	7
	13	16th March 1906	The Veterinary Assistant, Muzaffarnagar.	5,200	650	XXX	8
			Total	62,095	12,127		
Bengal	1	14th April 1905	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	9,000	3,000	XXIV	3
	2	16th May 1905	Ditto ditto	30,000	3,000	XXIV*a*	10
	3	1st July 1905	Ditto ditto	20,300	2,030	XXV	10
	4	15th ditto	Ditto ditto	20,300	2,030	„	10
	5	17th August 1905	Ditto ditto	10,000	2,000	XXVI	5
	6	24th ditto	Ditto ditto	10,000	2,000	„	5
	7	14th September 1905	Ditto ditto	10,000	2,000	„	5
	8	31st October 1905	Ditto ditto	10,150	2,030	„	5
	9	15th November 1905	Ditto ditto	3,500	350	XXV	10
				8,400	1,680	XXVI	5
	10	7th December 1905	Ditto ditto	10,030	2,006	XXVII	5
	11	31st ditto	Ditto ditto	15,040	3,008	„	5
	12	15th January 1906	Ditto ditto	15,075	3,015	„	5
	13	24th ditto	Ditto ditto	21,000	3,000	XXVIII	7

Issue—concluded.

Province.	Serial No.	Month and date of issue.	To whom consigned.	No. of cubic centimetres.	No. of doses calculated for plains animals.	Laboratory No. of serum.	Standard.
Bengal—*contd*	14	1st February 1906	The Chairman, District Board, Barisal	7,000	1,000	XXVIII	7
	15	3rd ditto	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	30,000	6,000	XXIX	5
	16	14th March 1906	Ditto ditto	24,000	3,000	XXX	8
	17	14th ditto	The Chairman, District Board, Chittagong.	4,000	500	„	8
	18	27th ditto	The Deputy Commissioner, Darjeeling	28,800	3,600	„	8
	19	27th ditto	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	16,000	2,000	„	8
			Total	302,595	47,249		
Central Provinces	1	28th June 1905	The Superintendent, Civil Veterinary Department, Central Provinces, Nagpur.	10,150	1,015	XXV	10
	2	16th August 1905	Ditto ditto	25,000	5,000	XXVI	5
	3	15th November 1905	Ditto ditto	25,190	5,038	„	5
	4	6th February 1906	Ditto ditto	35,000	5,000	XXVIII	7
			Total	95,340	16,053		
Madras	1	16th May 1905	The Superintendent, Civil Veterinary Department, Madras.	20,000	2,000	XXIV*a*	10
	2	5th September 1905	Ditto ditto	15,000	3,000	XXVI	5
	3	20th October 1905	Ditto ditto	15,000	3,000	„	5
	4	10th December 1905	Ditto ditto	10,005	2,001	XXVII	5
	5	20th January 1906	Ditto ditto	21,000	3,000	XXVIII	7
	6	16th March 1906	Ditto ditto	24,000	3,000	XXX	8
			Total	105,005	16,001		
Bombay	1	14th March 1906	The Superintendent, Civil Veterinary Department, Bombay, Poona.	40,000	5,000	XXX	8
			Total	40,000	5,000		
Assam	1	17th May 1905	Mr. Basu, Veterinary Inspector, c/o Deputy Commissioner Dibrugarh.	60,030	6,003	XXIV*a*	10
	2	11th August 1905	Director of Land Records and Agriculture, Assam, Shillong.	5,250	525	XXV	10
	3	5th October 1905	Dr. J. D. Gregorson, Tinsukia, Assam	4,180	836	XXVI	5
			Total	69,460	7,364		
Burma	1	25th April 1905	The Superintendent, Civil Veterinary Department, Burma, Rangoon.	21,000	2,100	XXIV*a*	10
	2	2nd June 1905	Ditto ditto	2,450	245	„	10
				77,550	7,755	XXV	10
			Total	101,000	10,100		
Foreign countries	1	27th July 1905	The Lieutenant-Governor, Malacca	1,000	100	XXV	10
	2	30th November 1905	The State Surgeon, Selangor	1,000	200	XXVII	5
	3	9th March 1906	The Principal Veterinary Surgeon, Singapore.	2,000	400	XXIX	5
			Total	4,000	700		
			GRAND TOTAL	1,270,645	199,131		
			Utilized in experiments, etc., at the Laboratory.	26,119	5,848		
			TOTAL ISSUE	1,296,764	204,979		

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX No. II.

Table showing the amount of Anthrax serum prepared and despatched during the year 1905-1906.

Amount manufactured.		Amount issued.		Remarks.
Stock.	c. c.	Abstract of issue.	c. c.	
Balance in hand from 1904-1905.	25,493	Issued as per detail below	129,900	
Manufactured during 1905-1906.	224,310	Used in experiments at the Laboratory .	3,663*	* Includes 18 c. c. not reported.
Returned from Shikarpur .	1,000	Tested serum in hand	85,890	
		Untested serum in hand	31,350	
Total .	250,803	Total .	250,803	

Issue.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Number of cubic centimetres.	Number of doses calculated for plains animals.	Laboratory No. of serum.	Standard.
							c. c.
United Provinces	1	30th June 1905 .	The Veterinary Inspector, c/o Tahsildar, Akbarpur, Fyzabad.	1,000	200	IX	5
	2	30th August 1905 .	The Veterinary Inspector, Circle I, Muzaffarnagar.	1,500	300	„	5
	3	5th September 1905 .	The Veterinary Inspector, Fyzabad .	1,000	200	„	5
	4	9th October 1905 .	Mohammad Shah, Veterinary Inspector, Gonda.	1,000	200	„	5
	5	11th November 1905	The Veterinary Inspector, Circle IV, Azamgarh.	1,500	300	„	5
	6	15th ditto .	The Veterinary Assistant, Bijnor .	1,800	360	„	5
	7	14th December 1905 .	The Superintendent, Central Jail, Bareilly.	350	70	X	5
	8	15th January 1906 .	Ditto ditto	350	70	X	5
	9	17th ditto .	Ditto ditto	1,400	280	X	5
			Total .	9,900	1,980		
Bengal . .	1	8th March 1906 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	5,000	1,000	XI	5
			Total .	5,000	1,000		
Assam .	1	17th May 1905 .	Mr. Basu, c/o Deputy Commissioner, Dibrugarh, Assam.	5,000	1,000	VIII	5
	2	22nd December 1905.	The Veterinary Inspector, Moriani, Assam.	5,000	1,000	X	5
			Total .	10,000	2,000		
Madras .	1	16th May 1905 .	The Superintendent, Civil Veterinary Department, Madras.	10,000	2,000	VIII	5
	2	17th June 1905 .	Ditto ditto	1,000	200	VII	5
				9,000	1,800	VIII	
	3	10th July 1905 .	Ditto ditto . .	15,000	3,000	IX	5
	4	5th September 1905 .	Ditto ditto . .	15,000	3,000	„	5
	5	20th October 1905 .	Ditto ditto . .	15,000	3,000	X	5

Issue—continued.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Number of cubic centimetres.	Number of doses calculated for plains animals.	Laboratory No. of serum.	Standard.
							c. c.
	6	10th December 1905.	The Superintendent, Civil Veterinary Department, Madras.	10,000	2,000	X	5
Madras—*contd.*	7	20th January 1906 .	Ditto ditto	13,500	2,700	„	5
				1,500	300	XI	
	8	16th March 1906 .	Ditto ditto . .	15,000	3,000	„	5
			Total .	105,000	21,000		
			GRAND TOTAL .	129,900	25,980		
			Utilized in experiments, etc., at the Laboratory.	3,663	732		
			TOTAL ISSUE .	133,563	26,712		

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX No. III.

Table showing the amount of Hæmorrhagic Septicæmia serum prepared and despatched during the year 1905-1906.

AMOUNT MANUFACTURED.		AMOUNT ISSUED.		REMARKS.
Stock.	c. c.	Abstract of issue	c. c.	
Balance in hand from 1904-05.	15,665	Issued as per detail below	89,120	
Manufactured during 1905-06.	75,350	Used in experiments	1,895	
Total .	91,015	Total .	91,015	

Issue.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Number of cubic centimetres.	Number of doses calculated for plains animals.	Laboratory No. of serum.	Standard.
							c. c.
	1	23rd June 1905 .	The Superintendent, Civil Veterinary Department, Punjab, Lahore.	1,000	200	I	5
	2	20th September 1905	Ditto ditto . .	500	100	II	5
	3	11th October 1905 .	Ditto ditto . .	5,050	1,010	„	5
	4	25th ditto .	Ditto ditto . .	5,000	1,000	III	5
	5	25th November 1905 .	Ditto ditto .	700	140	II	5
				4,300	860	III	
Punjab . .	6	31st December 1905 .	Ditto ditto .	210	42	II	5
				4,790	958	III	
	7	15th January 1906 .	Ditto ditto . .	5,000	1,000	IV	5
	8	26th ditto .	Ditto ditto . .	8,000	2,000	V	4
	9	5th February 1906 .	Ditto ditto . .	10,000	2,000	VI	5
	10	1st March 1906 .	Ditto ditto .	980	196	IV	5
				4,020	804	VI	
	11	12th ditto .	Ditto ditto . .	5,000	1,000	VII	5

Issue—continued.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Number of cubic centimetres.	Number of doses calculated for plains animals.	Laboratory No. of serum.	Standard.
							c. c.
Punjab—*contd.*	12	16th March 1906	The Superintendent, Civil Veterinary Department, Punjab, Lahore.	200	40	VI	5
				300	60	VII	
	13	30th ditto	Ditto ditto	6,800	1,360	VIII	5
			Total	61,850	12,770		
United Provinces	1	23rd June 1905	The Superintendent, Civil Veterinary Department, United Province, Lucknow.	1,005	201	I	5
	2	5th August 1905	The Veterinary Assistant, Banda	1,050	210	,,	5
	3	7th ditto	The Veterinary Inspector, Circle I, Bulandshahr.	1,050	210	,,	5
	4	23rd ditto	The Veterinary Inspector, c/o Collector, Muzaffarnagar.	2,000	400	,,	5
	5	23rd ditto	The Veterinary Inspector, II Circle, c/o Collector, Jhansi.	2,000	400	,,	5
	6	5th September 1905	The Veterinary Inspector, Fyzabad	500	100	,,	5
	7	12th ditto	The Veterinary Assistant, Muzaffarnagar.	1,500	300	II	5
	8	26th ditto	The Veterinary Inspector, Kulpahar	2,000	400	,,	5
	9	4th October 1905	Ditto ditto Ghazipur	1,000	200	,,	5
	10	14th ditto	Ditto ditto Kulpahar	2,100	420	,,	5
	11	17th ditto	Ditto ditto Fyzabad	500	100	,,	5
	12	28th ditto	Ditto ditto Kulpahar	2,500	500	III	5
			Total	17,205	3,441		
Bengal	1	8th July 1905	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	1,050	210	I	5
			Total	1,050	210		
Central Provinces	1	4th July 1905	The Superintendent, Civil Veterinary Department, Central Provinces, Nagpur.	500	100	I	5
			Total	500	100		
Madras	1	23rd June 1905	The Superintendent, Civil Veterinary Department, Madras.	1,005	201	I	5
	2	5th September 1905	Ditto ditto	2,500	500	,,	5
	3	14th December 1903	Ditto ditto	2,500	500	III	5
	4	16th March 1906	Ditto ditto	1,000	200	VII	5
			Total	7,005	1,401		
Bombay	1	4th July 1905	The Superintendent, Civil Veterinary Department, Bombay, Poona.	500	100	I	5
			Total	500	100		
Burma	1	23rd June 1905	The Superintendent, Civil Veterinary Department, Burma, Rangoon.	1,010	202	I	5
			Total	1,010	202		
			GRAND TOTAL	89,120	18,224		
			Utilized in experiments, etc., at the Laboratory.	1,895	379		
			TOTAL ISSUE	91,015	18,603		

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX No. IV.

Table showing the amount of English, French and Muktesar Mallein received or prepared and despatched during the year 1905-1906.

Stock.	Mallein doses.			Abstract of issue.	Mallein doses.		
	English.	French.	Muktesar.		English.	French.	Muktesar.
Balance in hand from 1904-1905 .	180	52	697	Issued as per detail below .	22	...	2,537
Received or prepared during 1905-1906	...	...	3,407	Used in experiments . .	...	...	47
				Balance in hand . .	158	52	1,520
Total .	180	52	4,104	Total .	180	52	4,104

Issue.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Mallein doses.			Laboratory No. of Muktesar Mallein.
				English.	French.	Muktesar.	
Punjab .	1	9th May 1905 . .	The Superintendent, Government Cattle Farm, Hissar.	...	...	50	II
	2	3rd June 1905 .	The Principal Veterinary Officer in India, Simla.	...	...	500	„
	3	20th February 1906 .	The Superintendent, Government Cattle Farm, Hissar.	...	...	100	III
	4	16th March 1906 .	The Superintendent, Mona Remount Depôt	...	...	100	V
			Total .	...	...	750	...
United Provinces.	1	28th May 1905	Major Maxwell, c/o the District Magistrate, Cawnpore.	...	...	12	II
	2	3rd October 1905 .	Officer in charge Remount Depôt, Saharanpur.	...	...	12	III
	3	20th January 1906 .	The Inspecting Veterinary Officer, Eastern Command, Meerut.	...	...	100	„
	4	9th March 1906 .	Ditto ditto .	...	...	830	IV
						170	V
			Total .	...	...	1,124	...
Bengal .	1	24th August 1905 .	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	...	...	70	II
						30	III
			Total .	...	...	100	...
Madras .	1	1st March 1906 .	The Superintendent, Military Stores, Bangalore.	...	...	50	III
			Total .	...	...	50	...
Bombay .	1	26th April 1905 .	The Principal, Veterinary College, Bombay	...	...	30	I
						20	II
	2	11th December 1905	Ditto ditto .	10	...	...	...
	3	23th March 1905 .	The Superintendent, Remount Depôt, Ahmednagar.	...	...	50	III
						50	V
			Total .	10	...	150	...

Issue—contd.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Mallein doses.			Laboratory No. of Maktesar Mallein.
				English.	French.	Muktesar.	
Assam	1	31st August 1905	The Secretary to Chief Commissioner, Assam, Shillong.	...	...	25	III
	2	3rd October 1905	Ditto ditto	...	...	25	„
			Total	...	...	50	...
Hyderabad, Sindh.	1	19th October 1905	Veterinary Graduate Asuda Mal, Hyderabad, Sindh.	...	...	10	III
			Total	...	...	10	...
Native States	1	27th July 1905	Commander in charge Patiala State Forces, Patiala.	...	...	6	II
	2	2nd September 1905	Veterinary Inspector, Kashmir State, Srinagar.	12	...	...	...
	3	14th October 1905	The Superintendent, Bagghikhana, Jammu, Kashmir.	...	...	25	III
	4	30th „ ditto	The Officer Commanding 1st Imperial Service Lancers, Jodhpur.	...	...	42	„
	5	17th November 1905	Ditto ditto	...	...	7	„
	6	12th January 1906	The Commandant, Imperial Service Troops, Jamnagar.	...	...	16	„
	7	12th ditto	The Commandant, Imperial Service Troops, Bhaunagar.	...	...	40	„
	8	12th ditto	The Commandant, Imperial Service Troops, Junagarh.	...	...	16	„
	9	20th February 1906	The Commandant, Imperial Service Troops, Bhaunagar.	...	...	40	„
	10	2nd March 1906	The Veterinary Officer, Jodhpur	...	...	80	„
			Total	12	...	272	...
Foreign Countries.	1	30th November 1905	The State Surgeon, Selangor, Straits Settlements.	...	...	6	III
	2	5th February 1906	Ditto ditto	...	...	25	„
			Total	...	...	31	...
			Grand Total	22	...	2,537	...
			Used in experiments, etc., at the Laboratory	...	...	47	...
			TOTAL ISSUE	22	...	2,584	...

ALFRED LINGARD,
Imperial Bacteriologist.

TABLE No. XV.

Showing main results of the working of the Imperial Bacteriological Laboratory during the year 1905-1906.

	QUANTITY OF SERA OR ANTI-TOXIN PREPARED AND ISSUED.						INSTRUCTION IMPARTED.					FINANCIAL RESULTS.										
								NUMBER ATTENDING CLASS.		NUMBER PASSED.		RECEIPTS.					EXPENDITURE.					
	Name of Sera or anti-Toxin.	Opening balance.	Prepared during the year.	Total.	Issued during the year.	Stock in hand.	Department or Province.	Veterinary officers.	Veterinary Inspectors and Assistants.	Veterinary officers.	Veterinary Inspectors and Assistants.	Sale of animals.	Sale of Sera.	Sale of garden products and revenue from reserved forests.	Other miscellaneous receipts.	Total.	Salaries and travelling allowance of officers and subordinate staff.	Feed and keep of animals.	Purchase of animals.	Cost of chemicals and apparatus.	Other miscellaneous expenditure.	Total.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
												R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.	R a. p.
Muktesar Laboratory.	Rinderpest serum	c. c. 359,598	c. c. 1,198,569*	c. c. 1,558,167	c. c. 1,296,764	c. c. 261,403	Army Veterinary Department.	4	...	4	...											
	Rinderpest serum in powder.	doses. 2,194	...	2,194	...	2,194	United Provinces	...	8	...	8											
	Anthrax serum	25,493	225,310†	250,803	133,563	117,240	Punjab and North-West Frontier.	...	12	...	12	...	182 8 0	499 7 1	62 14 3	744 13 4	46,566 15 9	15,244 11 5	2,988 3 6	‡ 8,151 13 3	§7,382 14 2	87,334 10 1
	Hæmorrhagic Septicæmia serum.	15,665	75,350	91,015	91,015	...	Central Provinces	...	17	...	17											
	Mallein	697	3,407	4,104	2,584	1,520	...	...	...		...											
Barielly Depôt.	...	...	...	...	...	...	United Provinces	...	5	...	5											
							Punjab and North-West Frontier Province.	...	8	...	8											
							Central Provinces	...	3	...	3	12 0 0	...	276 0 0	...	288 0 0	10,495 15 9	2,113 12 2	2,076 3 6	...	2,500 0 0	17,185 15 5
							Bengal	...	5	...	5											
							Bombay	...	3	...	3											
	TOTAL	c. c. 401,453 +doses. 2,194	c. c. 1,502,636	c. c. 1,904,089 +doses. 2,194	c. c. 1,523,926	c. c. 380,163 +doses. 2,194		4	61	4	61	12 0 0	182 8 0	775 7 1	62 14 3	1,032 13 4	57,062 15 6	17,358 7 7	12,064 7 0	8,151 13 3	9,882 14 2	1,04,520 9 6

* Contains 140,854 c. c. of untested serum.
† " 31,350 " " " and 1,000 c. c. returned from Shikarpur.

‡ Chemicals . 4,901 13 3
Library . 1,250 0 0
Bottles . 2,000 0 0
8,151 13 3

§ Includes R2,500 for fittings and furniture for Civil Veterinary Department and Army Veterinary Department Officers' quarters at Muktesar.

ALFRED LINGARD,
Imperial Bacteriologist.

No. 218—181 R. & A., dated Simla, the 18th August 1906.

From—Major H. T. Pease, I.C.V.D., Officiating Inspector-General, Civil Veterinary Department,

To—The Secretary to the Government of India, Department of Revenue and Agriculture.

I have the honour to submit, in proof, the report of the Imperial Bacteriologist for the official year 1905-06.

2. Good progress has been made in every direction in all the more important subjects dealt with at this institution. Dr. Lingard remained in charge during the year, Mr. Montgomery, the Assistant Bacteriologist, was replaced by Mr. G. D. Martin, M.R.C.V.S., and some additions have been made to the staff.

3. The manufacture of sera, etc., was continued, the output being greatly increased; and, in addition, a considerable amount of research work carried out. The classes for Veterinary Officers and Veterinary Assistants were held and four Army Veterinary Officers and sixty-one Veterinary Assistants were trained.

4. The fodder supply was satisfactory and arrangements are being made to increase the quantity available on the spot.

5. In order to cope with the manufacture of the great quantity of serum now required, the 8 horse power engine and centrifugal apparatus have been brought up to the Central Laboratory from Bareilly. Foot and mouth disease constantly broke out amongst newly bought animals, but owing to suitable arrangements having been made, no interruption of work resulted.

6. *Serum preparation.*—There is again a marked increase in the amount of serum produced. Last year, 151,855 doses of anti-rinderpest serum was prepared against 211,407 this year. Anthrax serum—27,471 against 44,862 this year. In addition to this, 15,470 doses of anti-hæmorrhagic Septicæmia serum was prepared against 3,133 last year.

7. *Rinderpest.*—The amount of anti-rinderpest serum is equal to 211,407 doses, of which 204,979 were issued to the Superintendents for use in the districts, or 74,169 doses more than last year, a remarkable increase.

8. The results of the application of the serum to the suppression of outbreaks have continued to be excellent, as the following table shows:—

Province.	Number of outbreaks.	Number of animals inoculated.	Number died after inoculation.	Percentage of mortality.
Punjab	170	50,759	18	0·035
North-West Frontier Province	54	15,176	12	0·07
United Provinces	60	5,814	54	0·92
Bengal	192	22,609	166	0·73
Central Provinces and Berar	128	7,187	8	0·11
Madras	154	12,054	44	0·36
Bombay	3	176	...	...
Assam	31	3,905	23	0·58
Burma	118	6,335	58	0·91
Total	910	124,015	383	
Last year	590	56,483	263	
Difference	+320	+76,532	+120	

The increase in the number of animals inoculated is therefore considerable, 76,532 more than last year, whilst the mortality remains insignificant.

9. *Anthrax.*—During the year 224,350 c. c. of Anthrax protective serum, equal to 44,862 doses, were prepared against 137,356 c. c. or 27,471 last year; and the demand for the serum was greater by 4,321 doses. The results,

obtained from its use are reported to be good. The returns show the following:—

Province.	Outbreaks.	Number of inoculated animals.	Number died after inoculation.	
				Per cent.
United Provinces	57	2,393	...	...
Assam	4	866	2	0·23
Madras	187	22,651	66	0·29
Total	248	25,910	68	...
Last year	187	19,287	...	...
Increase	61	6,623	68	...

The serum was used in 248 outbreaks and 25,910 animals were inoculated, with a mortality of only 68, against 187 outbreaks and 19,287 animals inoculated last year.

10. The remarks in regard to the use of the serum in an outbreak of Anthrax amongst human beings are interesting and the recommendation regarding the upkeep of a certain quantity of anthrax serum of high potency is worthy of consideration. The results obtained by Sclavo's anthrax serum in Europe have been excellent and the dangers of anthrax infection amongst human beings have been greatly reduced by its use.

11. *Hæmorrhagic Septicœmia.* It was noted last year that a serum for protection against this disease had been prepared and would be issued for trial in the field. This was done and the results are reported to have been very satisfactory. The manufacture of serum has been continued therefore but under considerable difficulties. There are no sheds for the reception of the extra animals required and they had to be accommodated in temporary chappars to protect them against the inclemency of the weather. The manufacture of the serum takes five months. It is very satisfactory to note therefore that in spite of these difficulties it was possible to produce 15,470 doses during the year. The demand was considerably more than this and could not be fully met; special arrangements have been made to meet the increased demand. The following returns have been submitted by the Superintendents who have used the serum:—

Province.	Number of outbreaks.	Number of animals inoculated.	Number died after inoculation.	Mortality per cent.
Punjab and North-West Frontier Province.	68	8,427	14	0·16
United Provinces	45	4,055	...	...
Madras	10	969	...	...
Total	123	13,451	14	0·104

These results are very satisfactory.

12. *Mallein.*—3,407 doses were prepared against 1,514 last year and 2,606 doses of Muktesar and 22 doses of English mallein were indented for by Superintendents, etc.

13. *Tuberculine.*—There is so far very little demand for this, only 31 doses being asked for during the year.

14. In addition to the preparation and issue of these sera, Dr. Lingard has been engaged in attempting to produce a serum against Charbon Symptomatique—a very prevalent and fatal disease in certain parts of the country.

A number of doses of vaccines prepared in various ways will soon be ready for issue to Superintendents for trial in the field. At present "Blacklegoids" are in use in certain Provinces and have so far given satisfaction as they are efficient and easy to use.

15. In the direction of research also the experiments with regard to the protective value of various anti-rinderpest sera prepared in different ways are of great interest. They show that it will possibly be found practicable to considerably increase the potency of the serum and hence reduce the dose required, which would result in considerable saving.

16. It has been proved that the Black buck is susceptible to rinderpest and capable of spreading it.

17. Work was continued with Piroplasmosis, Horse and Camel Trypanosomiasis, Anthrax, Hæmorrhagic Septicæmia, Charbon Symptomatique and Dourine.

18. Dr. Lingard reports the occurrence of Tuberculosis in the camel and Spirillum in cattle, and also of a new form of organism present in the erythrocytes of camels suffering from spontaneous trypanosomiasis.

19. The remarks regarding the reduction of the virulence of Bacillus Mallei are very interesting; a similar organism to that discribed by Mr. Lingard was also found in cases in the Lahore College Laboratory by Captain Baldrey.

20. In addition to the papers published by the Imperial Bacteriologist, Mr. Montgomery, Assistant Bacteriologist, has published "Observations on Bilharziosis in animals" and Captain Baldrey "some observations in normal and rinderpest blood." The work for these papers was carried out in the Muktesar Laboratory.

21. The report is interesting and valuable, the work done has been very great, the results excellent, and very great credit is due to Dr.. Lingard and his Assistants.

No. 1960—130-2, dated Simla, the 28th September 1906.

From—J. WILSON, Esq., C.S.I., I.C.S., Secretary to the Government of India, Department of Revenue and Agriculture,

To—The Inspector General, Civil Veterinary Department.

I AM directed to return the copy of the Report of the Imperial Bacteriologist for the year 1905-06, received with your letter No. 218—181 R. & A., dated the 18th ultimo.

2. I am to say that the Government of India are pleased to acknowledge the excellent work which has been done during the year by Dr. Lingard and his Assistants at the Laboratory both in the preparation of sera and in research.

3. With reference to paragraphs 64 and 65 of the Report, I am to say that the question of depositing stocks of Anthrax serum in jails should be separately referred to the Government of India for orders before any action is taken in the matter, and that at the same time details may be given as to the processes of manufacture of the serum and of bottling it.

G. I. C. P. O.—No. 8 I. G. C. V. D.—16-10-1906—328—H. R.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1906-1907.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1907.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1906-1907.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1907.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

ANNUAL REPORT

OF THE

IMPERIAL BACTERIOLOGIST

FOR THE YEAR

1906-1907.

Section I.

Administration.

No. 609, dated Muktesar, the 6th July 1907.

From—The Imperial Bacteriologist, Muktesar,

To—The Inspector General, Civil Veterinary Department, Simla.

I have the honour to submit my Annual Report for the year 1906-1907.

2. During the past year I was in charge of the Office of the Imperial Bacteriologist and Mr. G. D. Martin, M.R.C.V.S., that of the Assistant Bacteriologist. Mr. H. E. Cross, M.R C.V.S., was appointed by the Secretary of State for India to the India Civil Veterinary Department and was deputed by the Government of India to Muktesar as the Second Assistant Bacteriologist with effect from the 16th August 1906. Later, he was detailed to tour with the Superintendent, Civil Veterinary Department, United Provinces of Agra and Oudh, to learn something of local conditions. He left Muktesar for this work on the 4th October 1906, but returned by the orders of the Inspector General, Civil Veterinary Department, to the Laboratory in the beginning of January to assume the appointment of the Second Assistant Bacteriologist.

3. The preparation of different sera and other prophylactics occupied the attention of officers throughout the year.

In addition, experiments were conducted with a view to test the potency of Hæmorrhagic Septicæmia serum and also the efficacy of atoxyl in destroying the trypanosomata of surra and dourine. Experiments with the object of determining whether Indian elephants are susceptible to the *T. evansi* from an equine source were carried out, and observations were continued with regard to trypanosomiasis in camels.

Further, four Australian horses were immunized and hyperimmunized for the preparation of tetanus anti-toxin.

4. *Training of Veterinary Officers.*—During the months of June to September 1906, two officers of the Civil Veterinary Department and three of Army Veterinary Corps attended the theoretical and practical classes, each one lasting for two months. The subjects of training were the same as during the last year. The necessity of prolonging the period of training from two to four months was recognised by Government and sanctioned.

5. *Training of Veterinary Assistants.*—In the past year, 27 Veterinary Inspectors and Assistants were trained at Muktesar and 22 at Bareilly, making a total of 49. The decrease in the number of Veterinary Assistants from that of previous years, appears to be due either to the Provincial Superintendents being unable to spare their subordinates or the number of untrained men is becoming diminished.

6. During the past year, in addition to my other work, I published the following papers :—

(*i*) Flagellates found in the gastro-intestinal tracts of the horse-leech, Hæmopis Sanguisuga—*Journal of Tropical Veterinary Science*, Volume I, No. 3.

(*ii*) Further notes bearing on the *T. Equiperdum* with special reference to its presence in plaques, measurements under various conditions and the immunity conferred, if any, against the *T. evansi*, Volume I, No. 4.

(*iii*) Different species of trypanosomata observed in bovines in India, Volume 2, No. 1.

(*iv*) A note on a new species of Trypanosoma discovered in the blood of an Indian Bullock at Singapore, Volume 2, No. 2.

(*v*) Some forms of Spirochetosis met with in India, Volume 2, No. 3.

The following two papers are now ready for publication :—

(*a*) Are Indian elephants susceptible to trypanosomiasis ?

(*b*) Insusceptibility of the Indian elephants to rinderpest.

7. *Fodder supply.*—The arrangements for grass supply were satisfactory, but during the close of the year our stock of hay ran short owing to increase in the number of animals provided for the preparation of sera. At the beginning of the current financial year, the additional land mentioned in the previous year's Annual Report, has been acquired and arrangements are being made to enhance the supply of fodder.

8. *Forest.*—The forest area under the Laboratory Estate has been placed on a sound basis as far as the preservation of the forest is concerned. No fires, illicit fellings or damage of any other kind was reported during the past official year. Arrangements are being made to declare by a Government Notification the protected area recently obtained, as Reserved Forest.

Two thousand five hundred Deodars have been planted in suitable localities and were carefully protected during the winter season.

The nursery for the walnut trees has made good progress and the plants about 1,000 in number, are now of sufficient size to be transplanted during the ensuing rains.

9. *Meteorological Observations.*—The Muktesar Observatory has been declared as a third class departmental Observatory by the Meteorological Department and observations are communicated by wire every morning to the Simla office, instead of those previously supplied from Ranikhet. The collection and record of these observations continued as in previous years.

10. *Buildings.*—At the close of the past official year, the construction of some of the important buildings was completed, such as the Mallein and Tetanus Laboratories and the stables for the accommodation of tetanus and glandered horses. The additions to the engine house are now complete, and the engines are being erected. The new accommodation provides for the 12 and 8 H.-P. engine with 10 and 5 litres centrifuges as well as an ice machine, two small centrifuges previously worked by hand, and a lathe.

11. *Manufacture of wooden serum boxes.*—During the past two years all the necessary wooden boxes for the transportation of serum have been manufactured on the Estate from wood obtained locally.

Since July last, we have issued 410 boxes, and the average cost of each box comes to R3-8-0.

12. *Branch Laboratory at Bareilly.*—During the winter months the work was resumed at the Branch Laboratory at Bareilly. This included, test experiments on Hæmorrhagic Septicæmia and rinderpest sera, observations with regard to trypanosomiasis in equines, bovines, camels and elephants.

Further researches were made with regard to test the efficacy of Arsenic and trypanrot singly and in combination and also of atoxyl, in destroying the causal agents of surra and dourine. During the past cold season, the utility of the Branch Laboratory has been especially well exemplified in several ways. The winter season in Muktesar is generally severe, and experience has for several years shown us that anti-rinderpest serum testing carried out on hill cattle during that period at the hill Laboratory is not nearly so satisfactory in

the results as when conducted at Bareilly. Further, researches with regard to diseases in large animals, as for instance, elephants, camels can only be carried on, under plains conditions, in a Laboratory like that at Bareilly. In addition, when a succession of tests upon plains animals have to be conducted, such animals of different ages as are required are easily obtainable at short notice and at a less cost at Bareilly than at Muktesar.

13. *Staff and establishment.*—During the past year the services of a Hospital Assistant have been secured and the dispensary attached to the Laboratory is in working order. To show the great want of such an institute it is only necessary to state that the average monthly attendances during the month of May last amounted to 603 cases.

I take this opportunity of placing on record my warmest appreciation of the support I have invariably received from all the members of my staff and establishment.

With regard to the subordinate establishment, I would like to specially mention the names of Mr. Max Kriebel, European Head Laboratory Assistant and Babu Krishna Nand, Head Clerk.

Section II.

Research.

14. As during the last year, the work to be carried out within the year under review was proposed on the following diseases—

(i) Rinderpest.
(ii) Piroplasmosis and Trypanosomiasis.
(iii) Surra.
(iv) Anthrax.
(v) Hæmorrhagic Septicæmia.
(vi) Charbon Symptomatique.
(vii) Dourine.

Rinderpest.

15. *Serum exposed during two hot seasons in the plains.*—Serum No. XXIV despatched from Muktesar to Karachi (Sind) in March 1905, and allowed to remain in that station for a period of nearly two years, when returned to the Laboratory for the purpose of retesting was found to have lost 55 to 60 per cent. of its protective power.

16. *Serum prepared during the excessive cold of the winter 1906-1907.*—Contrary to expectation, it was observed that anti-rinderpest serum prepared during the cold season of the year, was 54 times weaker than that prepared during other seasons of the year. This was probably in part due to the poor condition of the hill animals, on their arrival at Muktesar.

It has been found more satisfactory to undertake the standardizing of anti-rinderpest serum on hill cattle during the winter months, at a station in the plains, as the great bulk of serum prepared is for use on plains cattle, which are not exposed to the excessive cold encountered in the mountaneous districts.

17. *Insusceptibility of the Indian Elephant to Rinderpest.*—In order to determine whether elephants are susceptible to Rinderpest and suffer from the disease during outbreaks amongst cattle and other animals a female elephant, in perfect health and condition, normal temperature ranging between 36 and 37·3° C., was subcutaneously inoculated with 500 c.c. of virulent defibrinated blood obtained from a hill bull the subject of well marked rinderpest. A diffused swelling occurred at the seat of inoculation, which had decreased in extent after a period of twenty-four hours and only a slight thickening of the skin was perceptible a few days later. No rise in temperature was recorded, and the animal never exhibited any untoward symptom of any kind, during the following twenty-three days.

18 *Spirochætosis in plains and hill cattle, affected with Rinderpest.*—This form of disease not previously recognized in this country, was met with, during the year under review, in hill and plains cattle. At a previous date (1894),

I recorded the presence of *Sp. bandicotti* in the blood of a percentage of *Mus* (*Nesokia*) *giganteus* in Poona. Rabbits and guinea-pigs inoculated subcutaneously with blood containing these spirochetes, concurrently with the Trypanosomata which the above-mentioned rodents harbour, contracted the disease, and death resulted in the majority of instances. A paper entitled "Some forms of Spirochœtosis met with in animals in India," detailing the results of this investigation, appeared in the July number of the *Journal of Tropical Veterinary Science*, to which I would refer the reader, for further details.

19. *Piroplasmosis and Trypanosomiasis.*—As opportunities offered, advantage was taken during the year to further the investigations with regard to Piroplasmosis and Trypanosomiasis in cattle.

In the *Journal of Indian Veterinary Science*, Volume II, No. I, a detailed report upon the different species of Trypanosomata observed in bovines in India has been published.

Spontaneous Equine Trypanosomiasis.

20. *The effect of the passage of the T. evansi from a spontaneous equine source through a series of equines.*—A strain of Equine Trypanosomiasis obtained from the Punjab was utilized for the purpose of this experiment.

During a period of sixteen months and twenty-two days, the trypanosoma was passed through a series of forty equines. Inoculation by a scratch on the nose and a trace of blood smeared into the scratch having been in the majority of instances resorted to. During the early period of these experiments, the incubation occupied from 4·5 to 6·5 days.

The course of the disease ran from 25 to a maximum of 42 days. During the latter period, the incubation period lasted 3 to 4·5 days, while the course of the disease terminating in death, in five cases, Nos. 36 to 40, took 4, 4, 3, 4 and 3 days respectively.

The period of incubation, and the course of the disease are more prolonged during the cold season in the plains, and simulate the forms of disease observed in animals located in the hills at 7,500 feet.

Further, when an equine was inoculated in the plains, with blood from an animal No. 40 of the series, (disease which terminated in death in three days), and was immediately removed to an elevation of 7,500 feet, instead of the animal succumbing in a period of three to four days, the course of the disease was immediately prolonged to twenty-eight full days.

The effect of passing the T. evansi through the body of small animals.

In the plains.

Rats.

21. (*a*) *Direct from the horse to the white rat.*—The period of incubation when white rats of 100 to 200 grammes body-weight are subcutaneously inoculated with 0·001 c. c. of horse blood containing a large number of flagellates, varies from 4·5 to 5·5 days. The course of the disease, from the first appearance of the flagellate in the blood until death, occupied 4 to 5 days.

(*b*) *After the sixty-seventh passage through white rats.*—The period of incubation of the *T. evansi* was reduced to a period of about 24 hours, while the course of the disease occupied about 40 hours.

(*c*) *After the seventy-eighth to the eighty-second passages through white rats.*—The period of incubation became still more reduced to seven hours, but the course of the disease remained at about forty-eight hours or a little under.

The virulence of the *T. evansi* of spontaneous equine trypanosomiasis, when inoculated into a country-bred pony, after the sixty-third passage through the white rat, was found to be but little affected, except with regard to the period of incubation which was reduced. The course of the disease, consisted of one long paroxysm which lasted thirty-six days and terminated in death.

Mice.

(*a*) *Direct from the horse to the white mouse.*—The period of incubation when white mice of 15 grammes body-weight are subcutaneously inoculated

with 0·001 c.c. of horse's blood, containing swarms of flagellates, varies from 5 to 5·5 days.

The course of the disease from the first appearance of the flagellate in the blood until death occupied five days.

(*b*) *After the thirty-sixth passage through white mice.*—The period of incubation was one and a half days and the course of disease occupied three days.

(*c*) *Between the thirty-seventh and forty-seventh passage through white mice.*—Instances occurred when the period of incubation became reduced to twelve hours and the course of the disease occupied two and a half to three days.

22. The *T. Evansi* of spontaneous equine trypanosomiasis, when inoculated into a country-bred pony after the forty-seventh passage through white mice, lost considerably in virulence, as evidenced by an equine living four times the period of the control animal.

Treatment by the administration of certain chemicals.
Lethal dose of atoxyl in small healthy animals.

IN THE PLAINS.

23. (*a*) *White rats.*—Three and a half cubic centimeters of a 1 per cent. solution of atoxyl, injected subcutaneously, brought about a fatal termination in 108 hours, in animals whose body-weights varied between 90 and 100 grammes, whereas four cubic centimetres of a 1 per cent. solution killed in 12·5 hours, and two c. c., of a 2 per cent. solution killed in 50 hours.

A dose of 3·5 c.c. of a 1 per cent. solution killed in 108 hours, but shortly after the injection was made, involuntary movements appeared, particularly circular movements of the head, running round in a circle, etc., while later, paralysis of the hind quarters was frequently observed.

These symptoms (involuntary movements) persisted for many months in some rats.

A dose of 3·0 c. c. was not productive of any symptoms, whatsoever.

IN THE HILLS.

At an elevation of 7,700 feet, white rats will not tolerate the dose of atoxyl administered in the plains without producing any symptoms.

Three c.c. of a 1 per cent. solution, in the great majority of instances, brings about a fatal issue in animals whose body-weight equals 80 to 100 grammes and more.

IN THE PLAINS.

(*b*) *Wild rats.*—(*M. decumanus*) are slightly more tolerant to atoxyl than white rats of the same body-weight.

The lethal dose for wild rats of 200 grammes body-weight was found to be 4·75 c.c., that for smaller animals, 100 grammes body-weight, 3·5 c.c., of a 1 per cent. solution. Therefore a rat of 200 grammes body-weight cannot tolerate an increase of 35 per cent. in the dose of atoxyl, fatal to the small one, although twice the body-weight.

IN THE HILLS.

All wild rats, whose body-weights varied between 80 and 112 grammes, succumbed to a dose of 2 c.c. of a 1 per cent. solution of atoxyl, within a period of 16·5 to 131 hours.

IN THE PLAINS.

(*c*) *Guinea-pigs.*—The lethal does of atoxyl, for guinea-pigs (390-420 grammes) was found to be 6 c.c. of a 1 per cent. solution. Death followed in about 61 hours, and with 3 c.c. of a 2 per cent. solution, death occurred

in about 39 hours. Animals of the above body-weight subcutaneously injected with 5 c.c. of a 1 per cent. solution always recover, without the exhibition of serious symptoms.

Guinea-pigs of 200 grammes body-weight always succumb to doses of 2·5 c.c. of a 1 per cent. solution of atoxyl in about 51 hours.

Lethal dose of atoxyl for healthy equines.

IN THE PLAINS.

24. (*a*) *Mules.*—Eight grammes of atoxyl per 400 lbs. body-weight, when injected into an animal of 504 lbs. body-weight, produced symptoms of slight colic, which soon passed off and the animal recovered.

Nine grammes of atoxyl, per 400 lbs. body-weight, when injected subcutaneously into an animal of 497 lbs. produced severe colic after 52 hours, and death in 84·5 hours.

IN THE HILLS.

Eight grammes of atoxyl, per 400 lbs. body-weight, when injected subcutaneously into mules of 540 and 584 lbs. brought about a fatal termination, in about 47 and 85 hours, respectively.

(*b*) *Australian Mares.*—Fifteen grammes of atoxyl in 2 per cent. solution produced no symptoms when injected subcutaneously into an animal body-weight 966 lbs.

A dose of 18·14 grammes in a 2 per cent. solution, injected into an animal of like body-weight, brought about severe symptoms of colic in 15 hours, but recovery followed; whereas 21·32 grammes in a 2 per cent. sulution, equivalent to eight grammes per 400 lbs. body-weight, brought about in a mare of 1,066 lbs. body-weight a fatal issue in 18·5 hours.

The effect of different doses of atoxyl in animals the subjects of spontaneous equine trypanosomiasis, and after a number of passages through white rats.

IN THE PLAINS.

Rats

25. (*a*) *Direct from the horse to white rat.*—Positive results have been obtained in all these cases in which 0·03 grammes of atoxyl (3 c.c. of a 1 per cent. solution) were injected primarily, when the trypanosomata were swarming in the blood of the peripheral circulation.

(*b*) *Rats inoculated with T. evansi, with virulent blood after the 67th to the 71st passage.*—A single dose of 0·03 grammes of atoxyl, showed no return of the flagellates during the succeeding 181 days.

(*c*) *After the 78th to the 82nd passages.*—Such rats when injected with 0·3 grammes of atoxyl, always succumbed to its effects in a few days, nor could animals of the same weight tolerate even a dose of 0·025, a fatal result always following within twelve hours to several days.

IN THE HILLS.

Eighty per cent. of all white rats inoculated with equine trypanasomiasis, from the fortieth passage through the horse, when injected subcutaneously with 3·0 c.c of a 1 per cent. solution of atoxyl, at the time when flagellates were swarming in the peripheral circulation, have succumbed within one to five days. A result exactly opposite to that obtained under similar conditions in the plains.

Guinea-pigs.

A dose of 0·01 grammes atoxyl kept the trypanosoma in abeyance for a period of sixteen days, while 0·02 grammes produced the same effect during twenty-eight days in a second animal of about the same body-weight, 400 grammes. When, however, the above doses were followed respectively by one of 0·03 grammes, in the former, death followed in thirty hours, while in the latter, the flagellate again absented itself, during a period of ten days, but death took place two days later.

The effect of different doses of atoxyl in equines, the subject of spontaneous equine trypanosomiasis.

26. A single dose of atoxyl (1 to 2 grammes) when injected subcutaneously is capable of temporarily destroying (for 4 to 5 days) the mature trypanosomata, when present in considerable numbers in the circulation of an equine. In order to totally destroy the immature forms of the flagellate, it is necessary to administer repeated doses of the drug 3 to 5 grammes on each occasion, at intervals of eight to ten days, according to the body-weight of the affected animal.

It must, however, be borne in mind, that equines the subjects of trypanosomiasis, especially when large numbers of flagellates are present in their blood, are much less tolerant of atoxyl than healthy animals, as was found to be the case with Arsenic in the form of Liq. arsenicalis.

27. *Are Indian elephants susceptible to inoculated equine trypanosomiasis?*—The evidence is fairly conclusive, *viz.*:—that old Indian elephants in health, are either insusceptible or only very slightly susceptible (maximum one flagellate in twenty fields of the microscope) to equine trypanosomiasis, even when the virluent material is injected subcutaneously in the comparatively large doses of 20 to 500 c.c. of blood containing the *T. evansi* in numbers.

28. *Is the casual agent of equine and camel trypanosomiasis, one and the same, viz., the T. evansi?*—As laid down by *Laveran* and *Mesnil*, the general opinion was primarily, that surra and nagana were two names for one and the same malady. They carried out experiments in order to solve the question, as to whether an animal protected against "nagana" could be injected by inoculation of surra material. The result of these experiments was that animals succumbed to surra, thus proving that the *T. evansi* and *T. brucei* are two species of flagellates quite distinct. If the experiments above referred to, on two goats and one buck, were sufficient to differentiate *T. evansi* from *T. brucei*, then the results of experiments with the animals now to be recorded, would tend to prove that the causal factor of camel trypanosomiasis is not one and the same species as that of equine trypanosomiasis (*T. evansi*).

I. A camel aged eight years, contracted trypanosomiasis spontaneously, in June 1901, and was kept under close observation, until death which occurred in September 1905. In February 1905, as the flagellates had been absent from the blood for several months, a pony was inoculated subcutaneously with 20 c. c. blood from the jugular vein of the camel. The pony, however subsequently, showed no rise in temperature or sign of the disease, although when inoculated at a later date with blood containing *T. evansi* contracted the disease and succumbed. Therefore, in February 1905, the blood of the camel did not contain the causal agent in the mature or immature form. In June 1905, during the season when the *Tabanus* was present in great numbers at an elevation of 7,750 feet, the camel was placed in a shed with a second camel which had been inoculated with spontaneous equine trypanosomiasis (numerous flagellates in the blood).

The animal, the subject of Tibersa, contracted the equine form of disease, incubation period about ten days and succumbed in sixty-two days.

II. A country-bred entire donkey, aged two years, was inoculated subcutaneously on 29th May 1905 with 0·2 c.c. of blood drawn from the jugular vein of a camel, the subject of spontaneous trypanosomiasis, trypanosomata swarming.

The period of incubation lasted 4·5 days.

Nineteen paroxysms occupied 93 days, and nineteen intermissions 334 or a total of 427 days. As on August 4th 1906, the blood of the donkey was incapable of conveying the disease on inoculation of susceptible animals, it was re-inoculated, but on this occasion with 1·0 c.c. of blood from a case of spontaneous equine trypanosomiasis. The period of incubation lasted 5·5 days. Seven paroxysms and seven intermissions occurred occupying 30 and 37 days, respectively, death taking place on the 15th October 1906.

The course of the disease occupied 67 days.

III. A donkey mare, aged five years, was subcutaneously inoculated on 18th February 1905 with 20 c.c. of blood direct from the jugular vein of a camel, the subject of spontaneous trypanosomiasis. The blood contained

numerous trypanosomata. Period of incubation 8·5 days. Twenty paroxysms lasting 79 days and twenty intermissions lasting 444 days followed, making a total of 523 days. On the 4th August 1906, the animal not having exhibited any trypanosomata in its blood, for several months, was tested with spontaneous equine trypanosomiasis, receiving 1·0 c.c. of blood subcutaneously (flagellates numerous). Period of incubation 6·5 days. Six paroxysms and six intermissions occurred, lasting 28 and 38 days, respectively. The animal, succumbed on 15th October 1906, 605 days after the primary and 73 days after the secondary inoculation.

From the results obtained from the above experiments, it will be observed that animals (camel and donkeys) which have acquired immunity for the casual factor of camel trypanosomiasis are still susceptible and succumb to the *T. evansi.*

29. *Hæmorrhagic Septicæmia.*—After having been passed through a succession of rabbits, the lethal dose for bovines of the organism of the disease in bouillon cultures, kept for 48 hours at 37°C., injected subcutaneously, was found to be as follows:—

Plains bulls of 280 to 300 lbs. body-weight, succumbed to a dose of 0·025 c.c. of bouillon culture when made up to 0·5 c.c. with saline solution, after a period of 93½ hours had elapsed.

Hill bulls of 180 lbs. body-weight, succumbed to a dose of 0·02 c.c. bouillon culture made up to 0·5 c.c. with saline solution after an interval of about 95 hours, but when the dose of culture injected was increased to 0·025 c.c., death took place in 47 hours.

When plains animals primarily immunized against Hæmorrhagic Septicæmia, were later hyperimmunized by the intravenous injection of successive doses of bouillon cultures, up to a maximum of 12·5, 25 and 35 c.c., respectively, the resultant sera were found to differ somewhat in protective power. The serum possessing the greatest potency was that obtained from the animals injected intravenously with 12·5 c.c. of the culture.

A quarter of a cubic centimetre (0·25 c.c.) of this latter serum was found to be capable of protecting a plains animal, body-weight 320 lbs., when a dose of 0·033 c.c. of virluent culture, was injected 48 hours after the subcutaneous injection of serum. Whereas a dose of 0·5 c.c. was found necessary to bring about a similar result when the 25 c.c. and 35 c.c. sera, were respectively tested.

The results of these experiments demonstrate that, instead of much time and attention being expended upon hyperimmunizing animals through a number of months, until 35 c. c. of the virulent cultures have been utilized, a serum of higher protective power may be obtained when a final dose of 12·5 c. c. has been intravenously injected.

Further, that a dose of 1 c. c. of such serum, four times the quantity used in the experiments for plains animals of 320 lbs. body-weight, should be sufficient to confer a passive protection for a period of several weeks, ample time for an outbreak of Hæmorrhagic Septicæmia to die out. For, the peculiarity of this form of malady is that outbreaks follow upon heavy rain, but they seldom or ever persist in one locality for a longer period than ten days.

30. *Charbon Symptomatique.*—Two forms of vaccines and an anti-serum have been prepared during the past official year. Up to the present, no returns have been received from the various Superintendents to whom the vaccine was supplied for testing in the field.

31. *Dourine.*—No fresh experiments could be initiated as the disease appeared to have completely died out and no virulent material was forthcoming.

The Arab horse treated with Arsenic and Trypanrot in the early part of 1906, has remained in good health and all signs of Dourine have disappeared, further this animal's blood is non-infective. In the other cases, which have been under observation, no further symptoms of the malady have been exhibited.

32. *Specimens examined.*—During the year under review, 80 specimens were submitted to the Laboratory for microscopical examination and report. In the majority of instances the result of examination was reported by wire, to the person interested with the least possible delay. The specimens revealed amongst others, the causal agents of Lymphangitis Epizootica and Trypanosomiasis, Piroplasmosis in cattle, horses, dogs, and Tubercle, etc.

Section III.

Applications of the result of research.

33. During the year under review, Foot and Mouth disease appeared as usual at the beginning of the cold season among the fresh hill bulls received through our agent in the Himalayas, but with careful precautions was confined to the outskirts of the Laboratory Estate.

34. *Rinderpest serum.*—During the past year, 1,779,876 c. c. or about 4,67,993 doses have been prepared and 1,661,709 c. c. or 4,58,661 doses were issued as per detail in Appendix I. The output and issue of the Anti-rinderpest serum during the last five years will be seen at a glance from the following statement :—

Year.	Quantity prepared.	Quantity issued.
	Doses.	Doses.
1902-03	73,288	87,791
1903-04	122,061	114,798
1904-05	151,855	130,810
1905-06	211,407	204,979
1906-07	467,993	458,661

35. To curtail the Annual Report, the following results of serum injections, carried out in the field by the Anti-rinderpest serum, have been collated from the past year's returns received in this office under each Province, instead of under each District, as in previous years.

36. *Rinderpest—*

Injections with serum alone.

Province.	Number of outbreaks in which inoculation was undertaken.	Number of animals which died uninoculated in course of outbreak.			Numbers of animals inoculated.			Numbers of animals which died after inoculation.			Remarks.
		Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
Punjab and North-West Frontier	329	...	4,649	...	...	93,489	...	...	47	...	
Bengal	103	...	2,348	...	...	10,367	...	...	57	...	
United Provinces of Agra and Oudh	190	...	498	...	...	11,669	...	...	2	...	
Central Provinces	141	...	2,344	...	...	7,816	...	...	26	...	
Madras	288	...	3,393	...	...	11,043	...	...	40	...	
Bombay	79	...	...	...	...	31,415	1	...	651	...	Includes returns from Bombay Veterinary College and Senior Veterinary Officer, Poona.
Eastern Bengal and Assam	142	...	4,355	35	...	27,220	115	...	67	...	
Burma	36	...	493	...	...	3,617	...	...	13	...	
Sind, Baluchistan and Rajputana	5	...	134	...	...	507	...	...	3	...	
Total	1,313	...	18,314	35	...	197,143	116	...	906	...	Death-rate 0·46 per cent.

On reference to the above table, it may be noted that during the year under report, 1,313 outbreaks were dealt with in which 197,143 cattle and 116 other species were injected by the "Serum alone" method against 124,015 in 1905-06. The mortality amongst the total injected animals was 0·46 per cent. as compared with 0·31 per cent. during the previous year.

In the Province of Bombay, out of 31,415 animals injected with serum 651 or 2·07 per cent. have been reported to have succumbed to the disease, clearly pointing to the fact that either some of the animals received serum when the disease was in its incubating stage or the cattle were more susceptible.

The returns forwarded by the Senior Veterinary Officer, Poona, from Neemuch and Mhow, show, that of 238 bovines, buffaloes and 1 camel injected, 5 deaths have occurred.

The returns submitted by the Principal, Bombay Veterinary College, point to the fact that 660 head of cattle were injected, but owing to the unavoidable circumstances no records of results obtained after inoculation could be collected. The value of the Anti-rinderpest serum in cutting short outbreaks which would otherwise have been of a serious nature, has now been well established. The Veterinary Officer of Cachar and Sylhet, Mr. McCaldron, M.R.C.V.S., etc., informs me that the result of serum injections carried on by him, during the close of the last financial year, were most satisfactory.

37. *Anthrax.*—During the year under report, 76,402 c. c. or 15,280 doses of Anthrax protective serum were prepared, as against 44,862 doses during 1905-06. The total issue, as per Appendix II, was only 11,814 against 26,712 doses during the previous year. The demand for this serum decreased considerably during the past year on account of its place being taken by the Hæmorrhagic Septicæmia serum. For this reason, the preparation of Anthrax protective serum was proportionate to the demand and a reserve stock of 26,914 doses was in hand at the close of the year under report. The following table, abstracted from returns received from the Superintendents, Civil Veterinary Department, will show the result of injections carried out in their respective Provinces:—

38. *Anthrax*—

Injections with Anthrax protective serum.

Province.	Number of outbreaks in which inoculation was undertaken.	Number of animals which died uninoculated in course of outbreak.			Number of animals inoculated.			Number of animals which died after inoculation.			Remarks.
		Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
Bengal	3	6	1	...	58	51	...	...	...	...	
United Provinces of Agra and Oudh	24	...	92	...	...	2,207	...	...	...	...	
Madras	105	...	602	...	...	8,856	...	...	1	...	
Eastern Bengal and Assam	5	6	80	...	6	1,490	...	...	3	...	
Total	137	12	775	...	64	12,604	...	...	4	...	

It will be noted from the above table that in 137 outbreaks of Anthrax, in which 12 equines and 775 bovines succumbed previous to inoculation being resorted to, 12,604 animals were protected, with only four deaths, after the administration of Anti-Anthrax serum.

39. *Hæmorrhagic Septicæmia.*—During the past year, 2,58,665 c. c. or 88,875 doses of Hæmorrhagic Septicæmia serum were prepared, against 15,470 doses during 1905-06. The total issue was 57,375 doses against 18,603 doses of the previous year. The results reported from the field were highly satisfactory and the demand was very great.

The following table collated from the statements received in this office, will show the result of injections :—

40. *Hæmorrhagic Septicæmia.*

Injections with Hæmorrhagic Septicæmia serum.

Province.	Number of outbreaks in which inoculation was undertaken.	Number of animals which died uninoculated in course of outbreak.			Number of animals inoculated.			Number of animals which died after inoculation.			Remarks.
		Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	Equines.	Bovines.	Others.	
Punjab and North-West Frontier . .	97	...	1,142	...	...	30,897	...	...	17	...	
United Provinces of Agra and Oudh . .	52	...	312	...	...	4,153	...	...	...	...	
Madras . .	37	1	66	...	...	675	...	...	...	...	
Eastern Bengal and Assam .	1	...	12	...	...	376	...	...	...	...	
Total .	187	1	1,532	...	...	36,105	...	...	17	...	Death-rate ·047 per cent.

It may be observed from the above return that, out of 36,105 bovines, injected with "serum alone" in 187 outbreaks, only 17 or 0·047 per cent. succumbed to Hæmorrhagic Septicæmia, after the injection of the Anti-Hæmorrhagic Septicæmia serum, although 1,532 had succumbed previous to its use.

41. *Charbon Symptomatique.*—During the year under report, both vaccines and a serum were prepared at Muktesar.

Doses of the 1st and 2nd vaccines	2,030
Doses of a second kind of vaccine	12,000
Doses of a serum	3,839
Total .	17,869

Out of 2,030 doses of the 1st and 2nd vaccines, 930 were issued, as per Appendix V, to the Superintendents of the various provinces for the purpose of trial in the field, but it appears from the above officers' reports that the same has not as yet been tested.

Further, the returns submitted by the Superintendents, Civil Veterinary Department, Punjab and United Provinces, show that during the year, 4,651 and 260 bovines were injected with Blacklegoids in their respective Provinces with two deaths in the former.

42. *Mallein.*—During the past official year about 11,276 doses of Mallein (including 2,044 doses of Pseudo-mallein and 5,000 doses of untested) were prepared at this Laboratory, as against 3,407 doses during the last year.

On reference to Appendix No. IV, it will be noted that the total issue during 1906-07 of English, French and Muktesar Mallein was 72, 20 and 3,583 doses respectively from the Imperial Bacteriological Laboratory.

43. *Tuberculine.*—During the year 1906-07, 30 doses of Tuberculine were issued, 20 to the Principal, Veterinary College, Bombay, 10 to the Inspecting Veterinary Officer, Bombay Command, Poona.

44. *Tetanus toxin.*—For the purposes of hyperimmunizing horses for the production of Tetanus anti-toxin 7,540 doses were prepared. Two horses out of four hyperimmunized have already furnished 22,164 c. c. tetanus anti-toxin, which will be tested as to necessary dose.

45. On reference to Table XV, the average cost of each dose, calculated on the total output of sera and other prophylactics against the budget grant sanctioned for the year under review, comes to R0-3-8, a highly satisfactory figure, as the expenditure of preparing such a dose at this Laboratory during 1904-05, was R0-8-4.

If Government had been obliged to purchase the various sera and prophylactics now prepared in quantities at Muktesar, in the open market, a sum of R6,08,833 would have been expended, calculating each dose at R1, the rates sanctioned by Government for foreign countries; but by the working of the Imperial Bacteriological Laboratory at an annual cost of R1,41,624 during the past year, a saving of R4,67,209 accrued. But as the Cape Government charges 2 shillings per dose R1-8, the saving at this figure amounts to R7,71,626.

APPENDIX No. I.

Table showing the amount of anti-Rinderpest serum manufactured and despatched during the year 1906-07.

Amount manufactured.		Amount issued.		Remarks.
Stock.	c. c.	Abstract of issue.	c. c.	
Balance in hand from 1905-1906.	261,403	Issued as per detail below	1,640,435	
Returned from District Board, Garhwal, during 1906-1907.	34,650	Utilized in experiments at Muktesar and Bareilly	21,274	
Manufactured during 1906-1907.	1,779,876	Tested serum in hand	298,940	
		Untested	115,280	
Total .	2,075,929	.....	2,075,929	
	Doses.	Serum in powder.	Doses.	
Balance in hand from 1905-1906.	2,194	Lost in breakage of a tube	12	
		Balance in hand	2,182	
Total .	2,194	.....	2,194	

Rinderpest.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Doses.	Laboratory No. of serum.
Punjab . . .	1	5th April 1906 .	Superintendent, Civil Veterinary Department, Punjab, Lahore.	1,000	XXX
	2	18th ditto .	Ditto ditto .	1,006	„
	3	18th ditto .	Veterinary Assistant Hafiz Ghulam Mohamad, Khushab.	700	„
	4	25th ditto .	Superintendent, Civil Veterinary Department, Punjab, Lahore.	1,006	„
	5	18th May 1906 .	Ditto ditto .	1,000	XXXI
	6	24th ditto .	Ditto ditto .	1,000	„
	7	25th ditto .	Veterinary Assistant Ghulamjilani, Veterinary Hospital, Peshawar.	1,000	„
	8	31st ditto .	Veterinary Assistant Ganga Ram, Palampur.	5,400	XXXII
	9	31st ditto .	Superintendent, Civil Veterinary Department, Punjab, Lahore.	1,625	XXXI
		31st ditto .	Ditto ditto .	375	XXXII
	10	9th June 1906 .	Ditto ditto .	2,000	„
	11	9th ditto .	Veterinary Assistant Ilm Din, Out-agency Hoshiyarpur, Railway Station, Jullundar.	1,000	„
	12	16th ditto .	Superintendent, Civil Veterinary Department, Punjab, Lahore.	1,000	„
	13	19th ditto .	Ditto ditto .	2,000	„
	14	6th July 1906 .	Ditto ditto .	2,000	XXXIII
	15	10th ditto .	Ditto ditto .	2,000	
	16	13th ditto .	Ditto ditto .	5,000	„

Rinderpest—continued.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Doses.	Laboratory No. of serum.
Punjab—*contd.*	17	20th July 1906	Superintendent, Civil Veterinary Department, Punjab, Lahore.	2,000	XXXIII
	18	26th ditto	Ditto ditto	5,000	„
	19	8th August 1906	Ditto ditto	2,000	XXXIIIa
	20	9th ditto	Veterinary Assistant Ganga Ram, Out-agency, Palampur, Pathankote.	3,625	„
	21	23rd ditto	Superintendent, Civil Veterinary Department, Punjab, Lahore.	10,000	„
	22	23rd ditto	Veterinary Assistant Ganga Ram, Palampur, Pathankote.	3,625	„
	23	5th September 1906	Superintendent, Civil Veterinary Department, Punjab, Lahore.	10,000	„
	24	14th ditto	Ditto ditto	10,000	„
	25	18th ditto	Veterinary Assistant, Out-agency, Palampur.	18,000	„
	26	3rd October 1906	Superintendent, Civil Veterinary Department, Punjab, Lahore.	10,000	„
	27	10th ditto	Ditto ditto	10,000	„
	28	31st ditto	Ditto ditto	10,000	XXXIV
	29	15th November 1906	Ditto ditto	15,000	„
	30	22nd ditto	Veterinary Assistant Ganga Ram, Palampur, Pathankote.	6,930	XXXVII
		22nd ditto	Ditto ditto	11,100	XXXIV
	31	1st December 1906	Superintendent, Civil Veterinary Department, Punjab, Lahore.	2,000	„
		1st ditto	Ditto ditto	8,000	XXXV
	32	12th January 1907	Veterinary Assistant Ganga Ram, Palampur, Pathankote.	18,000	„
	33	12th ditto	Superintendent, Civil Veterinary Department, Punjab, Lahore.	10,000	„
	34	18th ditto	Ditto Rawalpindi	2,625	„
		18th ditto	Ditto ditto	2,400	XXXVI
	35	21st ditto	Ditto Punjab, Lahore	10,000	„
	36	24th ditto	Senior Veterinary Officer, Rawalpindi	600	„
	37	14th February 1907	Superintendent, Civil Veterinary Department, South Punjab, Ferozepur.	10,000	XXXVII
	38	16th ditto	Veterinary Assistant Ganga Ram, Palampur.	15,000	„
	39	5th March 1907	Superintendent, Civil Veterinary Department, North Punjab, Rawalpindi.	5,000	XXXVIII
	40	13th ditto	Senior Veterinary Officer, Rawalpindi	10	„
	41	31st ditto	Superintendent, Civil Veterinary Department, Punjab, Lahore.	4,396	XXXIX
			Total	244,423	
United Provinces	1	28th April 1906	Veterinary Inspector, Unao	306	XXX
	2	7th May 1906	Ditto	262	„
	3	18th ditto	Ditto	200	XXXI
	4	29th ditto	Veterinary Assistant, Mirzapur	200	„

Rinderpest—continued.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Doses.	Laboratory No. of serum.
United Provinces —*contd.*	5	2nd June 1906	Veterinary Assistant, Unao	400	XXXII
	6	12th June 1906	Ditto ditto	50	,,
	7	19th ,, ditto	Veterinary Inspector, Unao	450	,,
	8	23rd August 1906	Veterinary Assistant, Moradabad	250	XXXIII*a*
	9	23rd ditto	Ditto Meerut	425	,,
	10	31st ditto	Ditto Shaharatganj	2,000	,,
	11	4th September 1906	Kabul Sing, Nagina	300	,,
	12	6th ditto	Tawaqul Hussain, Shaharatganj	1,000	,,
	13	11th ditto	Veterinary Assistant, Meerut	500	,,
	14	17th ditto	Ditto Ramsaroop, Gorakhpur.	425	,,
	15	25th ditto	Tahsildar, Kanauj	100	,,
	16	2nd October 1906	Veterinary Assistant, Moradabad	300	,,
	17	8th ditto	Ditto Muzaffarnagar	250	,,
	18	15th ditto	Ditto Hardoi	125	,,
	19	24th ditto	Superintendent, Civil Veterinary Department, United Provinces, Lucknow.	3,000	XXXIV
	20	23rd November 1906	Ditto ditto	3,000	,,
	21	27th December 1906	Ditto ditto	2,000	XXXV
	22	12th January 1907	Ditto ditto	5,000	,,
	23	24th ditto	Ditto ditto	5,000	XXXVI
			Total	25,543	
Bengal	1	1st June 1906	Superintendent, Civil Veterinary Department, Bengal, Calcutta.	2,000	XXXII
	2	22nd ditto	Ditto ditto	2,000	,,
	3	10th July 1906	Ditto ditto	1,000	XXXIII
	4	26th ditto	Ditto ditto	2,000	,,
	5	10th August 1906	Ditto ditto	2,000	XXXIII*a*
	6	29th ditto	Ditto ditto	5,000	,,
	7	23rd October 1906	Ditto ditto	3,000	XXXIV
	8	24th November 1906	Ditto ditto	1,000	XXXV
	9	12th December 1906	Ditto ditto	3,000	,,
	10	22nd ditto	Chairman, District, Board Palamau	1,000	,,
	11	22nd ditto	Superintendent, Civil Veterinary Department, Bengal, Calcutta.	2,000	,,
	12	24th ditto	Deputy Commissioner, Darjeeling	4,000	,,
	13	19th January 1907	Superintendent, Civil Veterinary Department, Bengal, Calcutta.	3,000	XXXVI
	14	26th ditto	Dit ditto	5,000	,,
	15	8th February 1907	Ditto ditto	10,000	,,
	16	20th March 1907	Ditto ditto	590	XXXVIII
	17	29th ditto	Ditto ditto	4,410	XXXIX
			Total	51,000	

Rinderpest—continued.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Doses.	Laboratory No. of serum.
Central Provinces	1	9th May 1906	Superintendent, Civil Veterinary Department, Central Provinces, Nagpur.	2,012	XXX
	2	16th June 1906	Ditto ditto	5,000	XXXII
	3	29th August 1906	Deputy Commissioner, Sambhalpur, Central Provinces.	1,000	XXXIII*a*
	4	12th January 1907	Superintendent, Civil Veterinary Department, Central Provinces, Nagpur.	5,000	XXXV
			Total	13,012	
Madras	1	14th May 1906	Superintendent, Civil Veterinary Department, Madras.	1,050	XXX
	...	14th ditto	Ditto ditto	1,950	XXXI
	2	30th June 1906	Ditto ditto	2,000	XXXII
	3	29th September 1906	Ditto ditto	2,000	XXXIII*a*
	4	2nd November 1906	Ditto ditto	2,000	„
	5	1st December 1906	Ditto ditto	2,000	XXXV
	6	14th ditto	Ditto ditto	4,000	„
	7	24th January 1907	Ditto ditto	2,000	XXXVI
	8	26th February 1907	Ditto ditto	4,000	XXXVIII
			Total	21,000	
Bombay	1	20th April 1906	Principal, Veterinary College, Bombay	500	XXX
	2	22nd May 1906	Superintendent, Civil Veterinary Department, Bombay, Poona.	2,000	XXXI
	3	5th July 1906	Ditto ditto	5,000	XXXII
	4	19th ditto	Principal, Veterinary College, Bombay	500	XXXIII
	5	11th August 1906	Superintendent, Civil Veterinary Department, Bombay, Poona.	3,000	XXXIII*a*
	6	24th ditto	Ditto ditto	4,000	„
	7	19th September 1906	Ditto ditto	5,000	„
	8	4th October 1906	Ditto ditto	750	„
	9	1st November 1906	Ditto ditto	5,000	XXXIV
	10	24th ditto	Inspecting Veterinary Officer, Bombay Command, Poona.	100	XXXV
	11	7th December 1906	Superintendent, Civil Veterinary Department, Bombay, Poona.	5,000	„
	12	22nd ditto	Principal, Veterinary College, Bombay	500	„
	13	18th January 1907	Superintendent, Civil Veterinary Department, Bombay, Poona.	5,000	XXX
	14	28th ditto	Veterinary Surgeon, Mehsana, North Guzrat, Bombay.	300	„
	15	14th February 1907	Superintendent, Civil Veterinary Department, Bombay, Poona.	417	„
	...	14th ditto	Ditto ditto	4,583	XXXVII
	16	18th ditto	Principal, Veterinary College, Bombay	500	„

Rinderpest—concluded.

Province.	Serial No.	Month and date of issue.	To whom consigned.	Doses.	Laboratory No. of serum.
Bombay—*contd.*	17	8th March 1907	Inspecting, Veterinary Officer, Western Command, Poona.	500	XXXVIII
	18	19th ditto	Superintendent, Civil Veterinary Department, Bombay, Poona.	5,000	,,
			Total	47,650	
Burma	1	20th July 1906	Senior Veterinary Officer, Burma, Division, Mandalay.	62	XXXII
	2	16th December 1906	Superintendent, Civil Veterinary Department, Burma, Rangoon.	10,000	XXXV
			Total	10,062	
Sind, Baluchistan and Rajputana.	1	22nd October 1906	Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana, Karachi.	1,000	XXXIII*a*
			Total	1,000	
Assam	1	9th May 1906	Mr. D. Ferguson, Dakshinabag	525	XXX
	2	23rd ditto	Veterinary Inspector, Moriani	3,000	XXXI
	3	21st June	The Chairman, District Board, Rajshahi	150	XXXII
	4	22nd ditto	Mr. D. Ferguson, Dakshinabag	500	,,
	5	9th July 1906	Deputy Commissioner, Cachar	500	XXXIII
	6	13th ditto	Veterinary Inspector, Moriani	5,000	,,
	7	14th ditto	Chairman, District Board, Chittagong	500	,,
	8	7th August 1906	Veterinary Assistant, c/o Deputy Commissioner, Jalpaiguri.	800	XXXIII*a*
	9	12th September 1906	Dr. H. Macormack, Sylhet	1,000	,,
	10	14th ditto	Veterinary Inspector, Moriani	5,000	,,
	11	27th December 1906	Manager, Sathgaon Tea Estate, Sathgaon	1,500	XXXV
	12	22nd January 1907	Ditto, Fagoo, Tea Estate, Domohani.	2,000	XXXVI
	13	26th ditto	Ditto, Tea Estate, Sathgaon	3,000	,,
	14	29th ditto	Veterinary Inspector, c/o Manager, Fagoo Tea Estate, Damdum.	3,000	,,
	15	13th February 1907	Mr. McCaldron, {Veterinary {Surgeon, Silchar.	10,000	XXXVIII
			Total	36,475	
Foreign Countries	1	24th April 1906	State Surgeon, Taiping, Perak	500	XXXI
	2	18th May 1906	Examiner, Supply and Transport Account, Port Blair.	500	,,
	3	22nd July 1906	Government Veterinary Surgeon, Singapore, S. S.	400	XXXIII
	4	13th August 1906	Executive Commissariat Officer, Port Blair.	250	XXXIII*a*
			Total	1,650	
			GRAND TOTAL	451,815	
			Utilized in experiments, etc., at the Laboratory.	6,846	
			TOTAL ISSUE	458,661	

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX No. II.

Table showing the amount of Anthrax Serum prepared and despatched during the year 1906-1907.

Amount manufactured.		Amount issued.		Remarks.
Stock.	c. c.	Abstract of issue.	c. c.	
Balance in hand from 1905-1906.	117,240	Issued as per detail below . . .	58,400	
		Used in experiments at the Laboratory .	670	
Manufactured during 1906-1907.	76,402	Tested serum in hand	134,572	
Total .	193,642	Total .	193,642	

Anthrax.

Province.	Serial No.	Date of issue.	To whom consigned.	c. c.	Doses.	Serum No.	Standard.
Punjab . .	1	27th October 1906 .	Veterinary Assistant Nihaluddin, Mankpur, Bengal and North-Western Railway.	600		XII	5
			Total .	600	120	...	...
United Provinces.	1	14th August 1906 .	Veterinary Assistant, Gonda .	1,500	300	XI	5
	2	14th ditto .	Ditto ditto, Azamgarh .	1,500	300	,,	5
	3	14th ditto .	Veterinary Inspector, Khaga, East Indian railway.	1,400	280	,,	5
	4	27th ditto .	Veterinary Assistant, Barabanki .	1,000	200	,,	5
	5	27th ditto .	Ditto ditto through Tahsildar, Khaga, Fatehpur District.	2,000	400	,,	5
	6	1st September 1906.	Veterinary Assistant, Sikandarabad, Bulandshahar District.	3,100	620	,,	5
	7	1st ditto .	Ditto ditto .	1,900	380	XII	5
	7	17th ditto .	Veterinary Assistant Ramsaroop, Gorakhpur.	600	120	,,	5
	8	8th October 1906 .	Veterinary Assistant, Azimgarh .	550	110	,,	5
	9	16th ditto .	Ditto ditto, Sitapur .	900	180	,,	5
	10	24th ditto .	Superintendent, Civil Veterinary Department, United Provinces, Lucknow.	5,000	1,000	,,	5
			Total .	19,450	3,990	...	...
Bengal . .	1	8th August 1906 .	Superintendent, Civil Veterinary Department, Bengal, Calcutta.	250	50	XI	5
	2	28th February 1907.	Ditto ditto . .	3,000	600	XII	5
			Total .	3,250	650	...	...
Madras . .	1	14th May 1906 .	Superintendent, Civil Veterinary Department, Madras.	5,000	1,000	XI	5
	2	30th June 1906 .	Ditto ditto .	10,000	2,000	,,	5
	3	29th September 1906	Ditto ditto .	5,000	1,000	XII	5
		29th ditto .	Ditto ditto .	5,000	1,000	XI	5
	4	24th January 1907 .	Ditto ditto .	10,000	2,000	XII	5
			Total .	35,000	7,000	...	...

Anthrax—continued.

Province.	Serial No.	Date of issue.	To whom consigned.	c. c.	Doses.	Serum No.	Standard.
Bombay . .	1	13th March 1907 .	Principal, Veterinary College, Bombay	100	20	XII	5
			Total .	100	20	...	...
			GRAND TOTAL .	58,400	11,680	...	...
			Utilized in experiments, etc., at the Laboratory.	670	134	...	...
			TOTAL ISSUE .	59,070	11,814	...	...

ALFRED LINGARD,
Imperial Bacteriologist.

C

APPENDIX No. III.

Table showing the amount of Hæmorrhagic Septicæmia serum prepared and despatched during the year 1906-1907.

AMOUNT MANUFACTURED.		AMOUNT ISSUED.		REMARKS.
Stock.	c. c.	Abstract of issue.	c. c.	
Balance in hand from 1905-1906.	*Nil*	Issued as per detail below . . .	224,350	
		Used in experiments . . .	2,815	
Manufactured during 1906-1907.	258,665	Tested serum in hand	31,500	
Total .	258,665	Total .	258,655	

Hæmorrhagic Septicæmia.

Province.	Serial No.	Date of issue.	To whom consigned.	c. c.	Doses.	Serum No.	Standard.
Punjab . .	1	2nd May 1906 .	Superintendent, Civil Veterinary Department, Punjab, Lahore.	5,000	1,000	IX	5
	2	16th ditto	Ditto ditto . .	1,025	205	„	5
		16th ditto .	Ditto ditto . .	3,975	795	X	5
	3	6th July 1906 .	Ditto ditto . .	5,000	1,000	„	5
	4	19th ditto .	Ditto ditto . .	10,000	2,000	XI	5
	5	24th ditto .	Ditto ditto . .	5,000	1,000	„	5
	6	26th ditto .	Ditto ditto . .	3,750	750	„	5
		26th ditto .	Ditto ditto . .	500	100	X	5
	7	30th ditto .	Ditto ditto . .	5,750	1,150	XII	5
	8	4th August 1906 .	Ditto ditto . .	5,600	1,120	„	5
		4th ditto .	Ditto ditto . .	4,500	900	XIII	5
	9	15th ditto	Ditto ditto . .	10,000	2,000	„	5
	10	19th September 1906	Ditto ditto . .	3,600	720	XIV	5
	11	1st November 1906 .	Ditto ditto . .	2,000	400	XV	5
	12	18th January 1907 .	Ditto Rawalpindi .	15,000	3,000	„	5
	13	5th February 1907 .	Ditto Lahore .	2,250	450	„	5
		5th ditto .	Ditto ditto .	47,750	9,550	XVI	5
	14	13th ditto .	Ditto Rawalpindi .	20,000	4,000	„	5
	15	7th March 1907 .	Chief Superintendent, Civil Veterinary Department, Punjab, Lahore.	12,750	6,375	XVII	2
	16	28th ditto .	Ditto ditto . .	10,000	10,000	XVIII	1
			Total .	173,450	46,515	...	...

Hæmorrhagic Septecæmia—contd.

Province.	Serial No	Date of issue.	To whom consigned.	c. c.	Doses.	Serial No.	Standard.
United Provinces	1	28th April 1906	Veterinary Inspector, Meerut	1,250	250	IX	5
	2	16th July 1906	Veterinary Assistant, Cawnpore	1,000	200	X	5
	3	11th ditto	Ditto ditto, Aligarh	1,500	300	„	5
	4	17th ditto	Ditto ditto	3,500	700	XI	5
	5	25th ditto	Veterinary Assistant, Unao	2,000	400	„	5
	6	7th August 1906	Veterinary Inspector, Sitapur	2,500	500	XIII	5
	7	14th ditto	Veterinary Assistant, Gonda	1,250	250	„	5
	8	17th ditto	Veterinary Inspector, Sitapur	2,500	500	„	5
	9	20th ditto	Veterinary Assistant, Etawah	1,000	200	„	5
	10	23rd ditto	Ditto ditto Moradabad	2,400	480	„	5
	11	24th October 1906	Superintendent, Civil Veterinary Department, United Provinces, Lucknow.	10,000	2,000	XV	5
			Total	28,900	5,780		
Bengal	1	9th June 1906	Superintendent, Civil Veterinary Department, Bengal, Calcutta.	5,000	1,000	X	5
			Total	5,000	1,000		
Madras	1	9th June 1906	Superintendent, Civil Veterinary Department, Madras.	5,000	1,000	X	5
	2	30th ditto	Ditto ditto	10,000	2,000	„	5
			Total	15,000	3,000		
Assam	1	23rd May 1906	Veterinary Inspector, Moriani, Assam	2,000	400	X	5
			Total	2,000	400		
			GRAND TOTAL	224,350	56,695		
			Utilized in experiment, etc., at the Laboratory.	2,813	680		
			TOTAL ISSUE	227,165	57,375		

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX No. IV.

Table showing the amount of English, French and Muktesar Mallein received or prepared and despatched during the year 1906-1907.

Stock.	Mallein doses.			Abstract of issue.	Mallein doses.		
	English.	French.	Muktesar.		English.	French.	Muktesar.
Balance in hand from 1905-1906	158	52	1,520	Issued as per detail below	72	20	3,573
Prepared during 1906-1907, including Pseudo and untested Mallein.	...	...	11,276	Used in experiments	...	...	10
				Balance in hand	86	32	9,213
Total	158	52	12,796	Total	158	52	12,796

Issue.

Province.	Serial No.	Date of issue.	To whom consigned.	Mallein doses.			Laboratory No. of Muktesar Mallein.
				English.	French.	Muktesar.	
Punjab	1	1st June 1906	Messrs. Jamasjee & Co., Peshawar	...	...	2	V
	2	6th ditto	Superintendent, Civil Veterinary Department, Punjab, Lahore.	...	...	25	"
	3	8th August 1906	Ditto ditto	...	...	25	"
	4	18th ditto	Superintendent, Remount Depôt, Mona	...	...	200	"
	5	22nd September 1906	Lieutenant, G. M. Routh, R.G.A., Kailana Camp, Chakrata.	...	...	1	"
	6	11th March 1907	Senior Veterinary Officer, Umballa	...	...	120	VI
	7	20th ditto	Ditto ditto, Lahore	...	...	125	"
	8	27th ditto	Ditto ditto, Sialkote	...	...	60	"
	9	Ditto ditto	Ditto ditto, Rawalpindi	...	...	20	"
			Total	...	...	578	
United Provinces.	1	16th May 1906	Superintendent, Civil Veterinary Department, United Provinces, Lucknow.	...	...	20	V
	2	19th ditto	Officer Commanding, 1st Lancers, Jhansi	...	...	5	III
	3	29th ditto	Inspecting Veterinary Inspector, Eastern Command, Naini Tal.	...	...	200	V
	4	26th July 1906	Superintendent, Army Remount Depôt, Babugarh.	...	...	6	"
	5	10th August 1906	Pt. Tek Chand, Veterinary Officer, Meerut	...	...	5	"
	6	10th ditto	M. Mohamad Shah, Veterinary Inspector, Bareilly.	...	...	5	"
	7	10th ditto	Mr. Amir Ahmad, Veterinary Inspector, Lucknow.	...	...	5	V
	8	10th ditto	Mr. Hussain Bux, Veterinary Inspector, Fyzabad.	...	...	5	"
	9	10th ditto	Mr. Imdad Hussain, Veterinary Inspector, Allahabad.	...	...	5	"
	10	10th ditto	M. Nasib Beg, Veterinary Inspector, Benares.	...	...	5	"
	11	22nd October 1906	Pt. Tek Chand, Veterinary Inspector, Meerut	...	...	5	"
	12	22nd ditto	M. Moin Khan, Veterinary Inspector, Agra	...	...	5	"
	13	23rd ditto	Superintendent, Civil Veterinary Department, United Provinces, Lucknow.	...	...	100	"
	14	5th December 1906	Superintendent, Remount Depôt, Babugarh	...	...	6	"
	15	21st January 1907	Inspecting Veterinary Officer, Eastern Command, Meerut.	...	...	200	"
	16	25th ditto	Veterinary Officer, Remount Depôt, Babugarh.	...	...	6	"
	17	6th February 1907	Inspecting Veterinary Officer, Eastern Command, Meerut.	...	...	200	VI
	18	9th March 1907	Veterinary Officer, Remount Depôt, Babugarh.	...	...	6	"
	19	20th ditto	Senior Veterinary Officer, Meerut	...	...	100	"
			Total	...	...	889	...
Bengal	1	6th June 1906	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	...	...	150	V
	2	6th July 1906	Ditto ditto	...	...	100	"
	3	25th ditto	Ditto ditto	...	...	100	"

Issue—contd.

Province.	Serial No.	Date of issue.	To whom consigned.	Mallein doses.			Laboratory No. of Muktesar Mallein.
				English.	French.	Muktesar.	
Bengal—*contd.*	4	12th November 1906.	The Superintendent, Civil Veterinary Department, Bengal, Calcutta.	...	...	200	V
	5	29th January 1907	Veterinary Officer, Remount Depôt, Calcutta	...	...	10	„
		29th „ ditto.	Ditto ditto	...	...	790	VI
			Total .	...	...	1,350	...
Bombay .	1	5th May 1906 .	Principal, Veterinary College, Bombay .	10	20	...	„
	2	16th August 1906 .	Ditto ditto	50	...	...	„
	3	21st September 1906.	Ditto ditto	...	...	50	V
	4	10th January 1907 .	Superintendent, Civil Veterinary Department, Bombay, Poona.	...	...	10	„
	5	18th February 1907 .	Principal, Veterinary College, Bombay .	...	...	50	VI
	6	8th March 1907 .	Inspecting Veterinary Officer, Western Command, Poona.	...	...	200	„
	7	9th ditto	Lieutenant Greenfell, Veterinary Officer, Karachi.	...	...	60	„
			Total .	60	20	370	...
Sind, Baluchistan and Rajputana.	1	9th February 1907 .	Officer Commanding 37th Lancers, Loralai .	...	...	40	VI
	2	9th March 1907 .	Station Veterinary Hospital, Quetta . .	...	...	100	„
			Total .	...	...	140	...
Burma .	1	15th January 1907 .	Superintendent, Civil Veterinary Department, Burma, Rangoon.	...	...	6	V
			Total .	...	...	6	...
Native States.	1	10th May 1906 .	Officer Commanding 3rd Skinner's Horse, Neemuch.	...	...	10	V
	2	3rd December 1906 .	Ditto 1st Imperial Service Lancers, Jodhpur.	...	...	18	V
	3	10th ditto	Veterinary Inspector, Sreenagar, Kashmir .	12	...	...	„
	4	9th March 1907 .	Senior Veterinary Officer, Trimulgherry (Hyderabad, Deccan).	...	...	70	VI
	5	15th ditto	Commandant, 1st Jodhpur Lancers, Jodhpur	...	...	14	„
	6	22nd ditto	Officer Commanding 3rd Skinners Horse, Neemuch.	...	...	100	„
	7	27th ditto	Inspecting Officer, Central India State Cavalry, Indore.	...	...	3	
			Total .	12	...	215	...
Foreign Countries	1	17th July 1906 .	State Surgeon, Selangor	...	...	25	...
			Total .	...	...	25	...
			Grand Total .	72	20	3,573	...
			Used in experiments .	...	...	10	...
			TOTAL ISSUE .	72	20	3,583	...

ALFRED LINGARD,
Imperial Bacteriologist.

APPENDIX No. V.

Table showing the amount of Charbon Symptomatique vaccine and serum manufactured and despatched during the year 1906-1907.

Amount manufactured.		Amount issued.		Remarks.
Stock.	Doses.	Abstract of issue.	Doses.	
Manufactured during 1906-1907—vaccine of two kinds.	14,030	Issued as per detail below . . .	vaccine 930	
		Balance in hand	vaccine 13,100	
Manufactured during 1906-1907—Serum.	3,839	Balance in hand—serum . . .	3,839	
Total .	17,869		17,869	

Issue.

Province.	Serial No.	Date of issue.	To whom consigned.	c. c.	Doses.	Laboratory No. of vaccine.	Standard.
Punjab . .	1	27th July 1906 .	Inspector General, Civil Veterinary Department, Simla.	...	10	I	
	2	11th September 1906	Superintendent, Government Cattle Farm, Hissar.	...	200	I	
			Total .	...	210	...	
United Provinces .	1	11th September 1906	Superintendent, Civil Veterinary Department, United Provinces, Lucknow.	...	250	I	
			Total .	...	250	...	
Bengal . .	1	11th September 1906	Superintendent, Civil Veterinary Department, Bengal, Calcutta.	...	50	I	
			Total .	...	50	...	
Central Provinces .	1	31st October 1906 .	Superintendent, Civil Veterinary Department, Central Provinces, Nagpur.	...	50	I	
			Total .	...	50	...	
Madras . .	1	11th September 1906	Superintendent, Civil Veterinary Department, Madras.	...	200	I	
			Total .	...	200	...	
Bombay . .	1	11th September 1906	Superintendent, Civil Veterinary Department, Bombay, Poona.	...	50	I	
	2	11th ditto .	Principal, Veterinary College, Bombay	...	50	I	
	3	13th March 1907 .	Ditto ditto .	...	20	I	
			Total .	...	120	...	
Burma . .	1	11th September 1906	Superintendent, Civil Veterinary Department, Burma, Rangoon.	...	50	I	
			Total .	...	50	...	
			Grand total .	...	930		

ALFRED LINGARD,
Imperial Bacteriologist.

TABLE XV.

Showing main results of the working of the Imperial Bacteriological Laboratory during the year 1906-1907.

	QUANTITY OF SERA OR ANTI-TOXIN PREPARED AND ISSUED.						INSTRUCTION IMPARTED.				FINANCIAL RESULTS.										
											RECEIPTS.					EXPENDITURE.					
	Name of Sera or Anti-toxin.	Opening Balance.	Prepared during the year.	Total.	Issued during the year.	Stock in hand.	Department or Province.	Number attending class: Veterinary Officers.	Number attending class: Veterinary Inspectors and Assistants.	Number passed: Veterinary Officers.	Number passed: Veterinary Inspectors and Assistants.	Sale of Animals.	Sale of Sera.	Sale of garden products and revenue from reserved forests.	Other miscellaneous receipts.	Total.	Salaries and travelling allowances of officers and subordinate staff.	Feed and keep of animals.	Purchase of animals.	Cost of Chemicals and Apparatus.	Other miscellaneous expenditure.	Total.
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
		c. c.	c. c.	c. c.	c. c.	c. c.						R a p	R a p.	R a. p	R a. p.	R a. p.	R a. p.	R a p	R a p.	R a. p.	R a p.	R a. p.
Muktesar Laboratory.	Rinderpest	621,403 *84,650	1,779,876	2,0 5,929	1,661,709	414,220	Civil Veterinary Department.	2	...	2	...											
	Rinderpest serum in powder.	2,194	...	2,194	12 (lost in breakage)	2,183	Army Veterinary Corps.	3	...	3	...											
	Anthrax serum	117,240	76,402	193,642	59,070	134,572	United Provinces	...	8	...	8											
	Hæmorrhagic Septicæmia.	...	258,665	258,665	227,165	31,500	Punjab	...	13	...	13											
	Mallein	1,520	11,276	12,796	3 583	9,213	Central Provinces	...	5	...	5	135 0 0	1,516 2 0	240 13 9	96 9 8	1,988 9 5	54,686 0 4	30,170 9 9	13,762 14 6	5,125 12 6	1,250† 20,944 12 5‡	1,25,940 1 6
	Charbon Symptomatique. vaccine	14,030	21,708		930	vaccine 13,100	Native States	...	1	...	1											
	Charbon Symptomatique. serum	7,678				serum 7,678																
							United Provinces	...	4	...	4											
Bareilly Depôt	...	...	...	...	...	...	Punjab	...	4	...	4	...	...	225 0 0	...	225 0 0	11,287 11 2	2,499 15 1	1,996 3 0	...	...	15,783 13 3
							Bengal	...	11	...	11											
							Bombay	...	3	...	3											
	TOTAL	417,007	2,147,927	2,564,934	1,952,469	612,465		5	49	5	49	135 0 0	1,516 2 0	465 13 9	96 9 8	2,213 9 5	65,973 11 6	32,670 8 10	15,759 1 6	5,125 12 6	22,194 12 5	1,41,723 14 9

* Returned from Garhwal.
† Rupees 1,250 Library allowance.

‡ Includes fitting and furniture charges of Institute, Dispensary, etc., together with cost of medicines.

ALFRED LINGARD,
Imperial Bacteriologist.

No. 215—189 R. & A., dated Simla, the 6th September 1907.

From—Major H. T. Pease, C.I.E., I.C.V.D., Inspector General, Civil Veterinary Department,

To—The Secretary to the Government of India, Department of Revenue and Agriculture.

I have the honour to submit, in proof, the report of the Imperial Bacteriologist for the official year 1906-07.

2. Dr. Lingard has been in charge of the laboratory during the whole year and the staff has remained the same, with the exception that Mr. H. E. Cross has been appointed as Second Assistant Bacteriologist and joined late in the year. Mr. Goffi was appointed as Third Laboratory Assistant and also joined on the 15th October 1906. The services of a Hospital Assistant have also been secured.

3. Work has, as usual, been carried out at Muktesar and Bareilly. Numerous important buildings have been completed, such as the Mallein and Tetanus laboratories and stables for Tetanus and Glandered horses. The machinery and engines are now all accommodated in one building so that two engines and centrifuges are available and the risk of breakdown is greatly diminished; other necessary machinery is also being connected up.

4. The various matters connected with the working of the laboratory have been successfully administered during the year. Fodder, owing to the increased number of animals kept, has been a difficulty, but is being arranged for. The Forest reserve has been carefully managed.

5. *Serum preparation.*—There is again a marked increase in the quantity of anti-rinderpest serum of which 467, 993 doses were prepared against 211,407 doses last year. The demand for Anthrax serum has considerably decreased, 15,280 doses were, therefore, prepared which was more than sufficient to meet the demand. Hæmorrhagic Septicæmia serum, on the other hand, has been required in greater quantity, so that 88,875 doses were made against 15,470 in the previous year. Last year, 3,407 doses of Mallein were prepared whilst this year's outturn was 11,276 doses. An anti-toxin for the prevention of Tetanus has been prepared for the first time this year, 7,540 doses being made. In addition to this, 17,869 doses of protective vaccines and serum for Charbon Symptomatique (Black Leg) have been prepared.

6. *Rinderpest.*—The amount of this serum issued to Superintendents of the Civil Veterinary Department is more than double that required last year. The following table gives the figures and results of the use of this serum in the field, the figures being supplied by the various Superintendents and others using it. From this it will be seen that the results have been excellent. The figures relating to the number of deaths of animals which died of the disease after inoculation are only approximate, being furnished in most cases by outside officials. The mortality after inoculation, however, is small and the good results obtained under present conditions are undoubted according to the reports received. No better proof of this can be advanced than the fact that the method is yearly becoming more popular:—

Province.	Number of outbreaks.	Number of animals inoculated.	Number died after inoculation.	Percentage of mortality.
Punjab and North-West Frontier Province	329	93,489	47	·05
Bengal	103	10,367	57	·55
United Provinces	190	11,669	2	·01
Central Provinces	141	7,816	26	·33
Madras	288	11,043	40	·36
Bombay	79	31,415	651	2·07
Eastern Bengal and Assam	142	27,220	67	·24
Burma	36	3,617	13	·32
Sind, Baluchistan and Rajputana	5	507	3	·59
Total	1,313	197,143	903	·45
Last year	910	124,015	383	·30
Difference	+403	+73,128	+520	+·15

7. *Anthrax.*—It has been already shown that the demand for Anthrax serum has considerably decreased. This disease is difficult to diagnose at present, the staff of Veterinary Surgeons available for the purpose being so extremely small. It appears probable that in former years Hæmorrhagic Septicæmia may have been treated as Anthrax. Far more care is now exercised in diagnosis and hence the decrease in the demand for Anthrax serum. The following table gives the results abstracted from the tables supplied by the various Superintendents who used the serum during the year. The mortality after inoculation is only approximate for the reason previously mentioned :—

Province.	Number of outbreaks.	Number of cattle inoculated.	Number died after inoculation.	
				Per cent.
Bengal	3	51	...	...
United Provinces	24	2,207	...	...
Madras	105	8,856	1	·01
Eastern Bengal and Assam	5	1,490	3	·20
Total	137	12,604	4	·03
Last year	248	25,910	68	·26
Difference	—111	—13,306	—64	—·23

8. *Hæmorrhagic Septicæmia.*—This serious disease is very prevalent at certain seasons of the year and causes serious losses. As will be seen from the following table, the disease is so far shown to be most prevalent in the Punjab. Efforts are being made to protect animals at the critical periods in villages where the malady is most prevalent. The following are the figures showing results so far as is known, extracted from the reports of the various Superintendents. The same remarks apply to them as to other sera :—

Province.	Number of outbreaks.	Number of animals inoculated.	Number died after inoculation.	
				Per cent.
Punjab and North-West Frontier	97	30,897	17	·05
United Provinces	52	4,153	...	...
Madras	37	679	...	...
Eastern Bengal and Assam	1	376	...	...
Total	187	36,105	17	·04
Last year	123	13,541	14	·10
Difference	+64	+22,654	+3	—·06

9. *Charbon Symptomatique.*—Two kinds of vaccine and a serum have been prepared for the protection of animals against this disease. Nine hundred and thirty doses of the ordinary 1st and 2nd vaccines were issued to Superintendents for trial during the year, but, so far, no reports have been received as to the results obtained from their use. It is not so convenient as the single vaccine obtainable and known as Blacklegoids which has been used in 4,911 cases with apparently good results. The double vaccine is not very suitable for India owing to the time required to carry out protection with it.

10. *Tuberculine.*—Only 40 doses of this material have been asked for during the year.

11. *Tetanus anti-toxin.*—This anti-toxin has been prepared for the first time at the laboratory this year and 22,164 c. c. are ready for testing. It will prove very useful in places where Tetanus is prevalent after injuries and operations, Bombay for instance. So far the demand has been small, but probably it will be required in moderate quantity as the operations of the Department extend.

12. *Mallein.*—The demand for Mallein increased considerably, 7,220 doses were asked for. The supply from outside sources has now been discontinued.

13. *Cost of serum.*—Calculated on the total expenditure of the Laboratory, the cost of serum, per dose, is only 3 annas 8 pies which is very cheap comparatively.

14. In addition to the administration and general routine work, such time as has been available has been devoted to research work. It has been ascertained that serum kept at Karachi for two years had lost 55 to 60 per cent. of its protective power. An opportunity was taken to inoculate an elephant with a large dose of rinderpest blood to ascertain whether she would take the disease. The result was negative, which proves that she possessed either natural or acquired immunity.

15. Spirochætosis is reported in cattle. As opportunities offered, Piroplasmosis and Trypanosomiasis in bovines was studied.

16. Some experiments in the treatment of Trypanosomiasis (Surra) by the administration of Atoxyl were carried out ; further experiments are required in this direction. The susceptibility of the Indian elephant to Surra (Equine) was tested and the results point to the conclusion that old elephants have considerable or total immunity to the disease.

17. Experiments were also made to ascertain whether Equine and Cameline Surra are due to the same Trypanosoma, but are not conclusive ; the evidence points to the possibility of their being due to different organisms.

18. A number of papers on the subject of Tropical diseases have been published during the year. It will be seen that the work done has been very great and valuable, and the results reflect great credit on Dr. Lingard and his Assistants.

No. 1834, dated Simla, the 16th October 1907.

From—J. WILSON, Esq., C.S.I., I.C.S., Secretary to the Government of India,
DEPARTMENT OF REVENUE AND AGRICULTURE,

To—The Inspector General, Civil Veterinary Department.

I AM directed to return the copy of the report of the Imperial Bacteriologist for the year 1906-07 received with your letter No. 215—189 R. & A., dated the 6th ultimo.

2. The report, which is the last that will be submitted by Dr. Lingard, is a record of another year's good work at the Laboratory. The increasing success of the system of inoculation in combating outbreaks of rinderpest, the best evidence of which is to be found in the growing popularity of the system in some parts of the country, and the weakening of the prejudices against it in others, is especially satisfactory, while its actual value to the country in the preservation of agricultural stock must be very great. Dr. Lingard retired from the Civil Veterinary Department on the 1st September last, and the Government of India desire to take this opportunity of placing on record their appreciation of the valuable services rendered by him to veterinary science in India during the 17 years in which he has held the office of Imperial Bacteriologist.

G. I. C. P. O.—No. 2 I. G. C. V. D.—2-12-1907—350—J. A.

00134324

Digitized with financial assistance from

Government of Maharashtra

on 01 February, 2020